STATISTICS
IN
INDIAN UNIVERSITIES

Report of the
University Grants Commission
Review Committee

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FOREWORD

The University Grants Commission appointed in 1959 a review committee in mathematics to broadly survey and assess the standards of teaching and research, the facilities available for the purpose and to recommend steps to be taken in order to raise the general level of academic attainment in research in the subject of mathematics in the universities. The committee submitted its report in 1962.

In April 1967, the Commission appointed a review committee in statistics under the chairmanship of Professor R.S. Verma of Delhi University for examining the existing facilities in the universities for teaching and research in the field of statistics, both pure and applied, and to recommend steps for the improvement of the courses of study and promotion of research in the subject.

The committee visited a number of university departments as well as government industrial establishments which recruit statisticians, and held several meetings to discuss problems relating to education and research in statistics.

Statistics has been a subject of high importance in a wide variety of fields and one of our important and urgent needs is to raise the level of teaching in this subject in the universities.

I have no doubt that the report of the committee and its recommendations will be of real value and benefit in improving the pattern and content of course of study (including the reform of syllabus) in statistics and in the promotion of research in the universities.

The Commission is grateful to members of the committee and all others who helped in making this review possible.

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D. S. Kothari
Chairman
University Grants Commission

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New Delhi
August, 1969.

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INTRODUCTION

Science is developing these days at an explosive rate, and accordingly statistics which is the key technology of the modern science has become all the more important as a discipline applicable to several other branches of human knowledge. The University Grants Commission, seized of the problem, appointed a Review Committee in Statistics with the following members:—

1. Professor V. S. Huzurbazar,
   Head of the Department of Mathematics & Statistics,
   Poona University, Poona.

2. Professor P. V. Krishna Iyer,
   Head of the Department of Statistics,
   Panjab University, Chandigarh.

3. Professor P. K. Bose,
   Pro-Vice-Chancellor (Academic affairs),
   Calcutta University, Calcutta.

4. Professor K. Nagabhushanam,
   Professor (Emeritus),
   Anthra University, Waltair.

5. Professor S. Chakravarti,**
   Professor of Mathematical Economics,
   Delhi School of Economics, Delhi.

6. Professor (Miss) A. George,
   Head of the Department of Statistics,
   Kerala University, Trivandrum.

7. Professor D. V. Rajalakshmanan,
   Head of the Department of Statistics,
   Madras University, Madras.

8. Professor R. S. Verma,
   Dean Faculty of Mathematics,
   Delhi University, Delhi.

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* At present with the university of Queensland, Brisbane.
** At present with the university of Johns Hopkins, Baltimore.

At the suggestion of this committee, Professor R.S. Verma accepted to work as chairman. At the first meeting held on 1st August 1967, Dr. N.S.R. Sastry, formerly Statistical Adviser, Reserve Bank of India, Bombay was co-opted as a member. Professor D.V. Rajalakshmanan of Madras University could not work on the committee, as he left for an assignment outside India. Subsequently, when Professor S. Chakravarty and Professor P.V. Krishna Iyer went to U.S.A. and Australia respectively the committee co-opted the following also as members:—

1. Professor M.C. Chakrabarti,
   Head of the Department of Statistics,
   Bombay University.

2. Professor N.M. Bhatt,
   Head of the Department of Statistics,
   M.S. University of Baroda.

The terms of reference of this committee as notified by the University Grants Commission are abstracted in the following para:—

The Statistics Review Committee would be primarily concerned with the teaching/research of the subject in the Universities and their colleges in all its aspects and suggest such steps as might be necessary for:—

(a) modernizing the syllabi and raising the general standards of teaching and research in both pure and applied statistics;

(b) improving the course content in statistics prescribed as a subject for graduates in other disciplines like commerce, business management, engineering and medicine;

(c) achieving uniformity of standards in the teaching of statistics in the various universities as a *principal* as well as a *subsidiary* discipline; and

(d) establishing greater collaboration between university departments of statistics and research cells/wings of industrial establishments.

The committee had sittings at Ahmedabad, Anand, Bangalore, Baroda Bombay, Calcutta, Delhi, Dibrugarh, Gauhati, Hyderabad, Jaipur, Madras Poona, Shillong, Trivandrum and Varanasi for discussions on the various aspects of the problems with which the members were confronted. The committee also investigated into the requirements, besides seeking the opinions of the heads of the departments of statistics in various universities of the potential employers (Arbeitsgeber) of statistics graduates with a view to give suitable shape to their findings in the form of the present report It was in pursuance of the latter idea that the committee visited several important industrial, technical and governmental concerns at various places. Thus nine meetings in all were convened at various places.

The ultimate form of the report of the review committee consists of seven chapters and a few appendices. The appendices include material collected by the committee.

1. Introduction.
2. Growth of Statistics in India.
3. Review of Existing Arrangements for Teaching Statistics.
4. Proposed Syllabi.
5. Research in Universities.
6. Viewpoints of 'Arbeitsgeber'.
7. Recommendations.

Appendices I to VI

The committee had a joint session with the Indian National Committee for Statistics on the 28th October, 1967, at the Central Statistical Organisation, New Delhi. It also had the benefit of discussions with

1. Professor K.B. Madhava at Madras,
2. Professor P. C. Mahalanobis at Delhi,
3. Professor U. S. Nair at Trivandrum, and
4. Professor P.V. Sukhatme at Delhi.

It has not been possible for the committee to frame syllabi for statistics in respect of medical and engineering courses.

The committee wishes to thank all the persons who have rendered assistance to the committee. It is hoped that the report will be of use in promoting teaching and research in statistics in India.

The committee places on record its deep appreciation of the valuable services rendered by Mr. S. Viswanath, Education Officer, University Grants Commission, without whom it would have been difficult to accomplish the task entrusted to us.

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GROWTH OF STATISTICS IN INDIA

Statistics, in the sense of Political Arithmetic, has been known to India since early days. As a scientific discipline, however, it crept its way in the thoughts and ideas of a few enthusiasts in the second decade of this century and has emerged half a century later as the key technology of the country. The annals of statistics in India divide itself into three distinct periods viz.,

(i)   The period prior to 1931,
(ii) The period 1931-1946,
(iii) The post independence period from 1947 and afterwards.

Prior to 1931

During the earlier part of this period much cannot be said of statistics except in the sense of statecraft. Although a handful of organizations were engaged in the compilation, analysis and release of official data even during the earlier part of the first priod, whatever statistics were collected as a by-product, of administration were at best inaccurate, nonuniform and inadequate. The first significant development in the nineteenth century was the setting up of a statistical committee in 1862 with a view to preparation of model statistical forms for compilation of a uniform system of imperial statistics on trade, finance education, population, agriculture, livestock, mining, industry, judicature etc. This led to the publication, in 1868, of the 'Statistical Abstract of British India' from London containing useful statistical information relating to each aspect of the Indian Economy and benefitting the traders and industrialists of Britain. This publication continued as an annual publication till 1923 when it was transferred to India.

To scrutinise and collate the huge mass of agricultural data flowing in from provincial departments and to look after statistics of foreign trade earlier compiled and published by the Finance and Commerce Department, a central 'Statistical Bureau' was set-up in 1895 to co-ordinate both agricultural and foreign trade statistics, besides being responsible for collection of Statistics of wages, prices and industries. The bureau functioned till 1922 under the guidance and supervision of a Director General of Statistics.

In 1905 the Director of Commercial Intelligence and Statistics replaced the Director General of Statistics with the additional function of bringing

about liaison between the business community and the government. Next year this department came out with the weekly *Indian Trade Journal* which still continues. In 1912 the Statistics Section was separated from the work of commercial intelligence and transferred to Delhi under an exclusive director of statistics. In 1922 again these two agencies were amalgamated in the Directorate General of Commercial Intelligence and Statistics at Calcutta which continued, till the establishment of exclusive organisations much later, to be the only important organisation dealing with agriculture, industry and trade.

In 1916 the Government of India appointed an Industrial Commission which recommended the appointment of a Director of Commercial and Industrial Intelligence to deal with

(i) statistics of foreign trade,

(ii) production and industrial statistics, and

(ii) statistics of trade of India and foreign countries tariff and industrial policy.

Unfortunately, its recommendations could not be accepted owing to technical difficulties.

In 1924 the Indian Economic Enquiry Committee set-up under the chairmanship of the late Sir M. Visveshwarayya recommended the conduct of a quinquennial wage census in large scale industries, compilation of statistics regarding products raised and raw materials consumed in cottage industries and of employment in industries, legalisation of statistical organisation and placing central and provincial departments under a central authority and a provincial bureau respectively.

On the recommendation of the Royal Commission on Agriculture the Imperial Council of Agricultural Research came into existence in 1930 to promote, guide and co-ordinate agricultural research and to compile and distribute statistical information concerning agriculture and animal husbandry.

The Royal Commission on Labour in 1931 enabled collection of statistics of prices, rent, wages, living costs etc. for industrial labour.

All this relates to statistics in the sense of statecraft. In 1917 the University of Calcutta appointed a committee to enquire into the examination system of the University. Professor P. C. Mahalanobis helped in the work of the committee by using statistical methods. This led to Mahalanobis starting work on statistical problems.

The then Director of the Zoological and Anthropological Survey of India, in 1920 inspired Mahalanobis to take up a systematic work on a statistical study of the anthropometric measurements. At the instance of the Director General of Observatories, Mahalanobis undertook a statistical study of some meteorological problems. This resulted in two memoirs and a

note on upper air variates in 1923. In 1928 Mahalanobis did some significant statistical studies relating to the problems of flood control. His suggestions were later found to be effective. He also tried to use statistical methods in agricultural field experimentation as early as 1926. Professor Mahalanobis went to England in 1926 and came in close touch with the pioneers in the field of statistics. After his return from Europe he gathered around him a group of young research workers to form the nucleus of his statistical laboratory. During this period very little interest was shown to statistics in Indian universities. During this whole period official statistics developed as a statecraft as a bye product of the administration, and not much of scientific methods were required or used for collection or analysis of data; however, in a few universities, where particular individuals were interested in this new discipline, elementary courses of statistics were started.

In 1924, Mysore University introduced a mixed course on economics, mathematics and statistics at the honours level and also appointed a professor of statistics. Madras University also was teaching statistics in the B.A. (Hons.) Mathematics course. In both the universities the standard of teaching was elementary.

The period—1931-1946

Milestones in the history during the second period are the establishment of the Indian Statistical Institute in 1931, setting-up of the Bowley-Robertson Committee in 1934, holding of the first Indian Statistical Conference at Calcutta in 1938, initiating the first large scale sample survey on Jute Crop in 1937, the introduction of the first full-fledged post graduate course on statistics by the Calcutta University in 1941, recognition of statistics as a separate section by the Indian Science Congress Association in 1945, establishment of the Indian Standards Institution in 1945 and the setting-up of the Gregory Committee in 1946.

From the nucleus of a statistical laboratory, the Indian statistical Institute developed into a full-fledged research institute. At a meeting held on December 17, 1931 in Calcutta, the Indian Statistical Institute was born as a non-profit distributing learned society and was registered as a society on April 28, 1932. In July 1932 began professional training in the institute on entirely an individual basis. Twelve to fifteen officers in government departments or scientific institutions were coming every year for short training courses. Gradually, young scholars began to join on completion of master's course. In course of replying to queries on the application of statistical methods to a variety of subjects such as field trials, plant physiology, bacteriological surveys, forest research, soil deterioration etc., a series of *Statistical Notes for Agricultural Workers* were prepared by the research workers of the institute, out of which more than 25 were published in the Indian Journal of Agricultural Research between 1932 and 1940.

From 1932 the Institute started holding regular scientific meetings where statistical papers on both theoretical and practical problems were

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presented. Theoretical research began in 1933 in the Institute. In June 1933 came out the first issue of *Sankhya. The Indian Journal of Statistics* and attracted the attention of the statisticians all over the world.

The Institute was doing promotional work in other directions as well. A note on the need for organising statistical studies was submitted to the Government of Bengal in 1933. Another note emphasising the need of introducing SQC* was presented in 1934 to the Government of India. In 1935 a committee was set-up to report on professional examinations in statistics and on the basis of its recommendations the Institute started annual (external) examinations in statistics in 1938. In 1935 the Institute received its first Government grant for research and training and a small whole-time staff was appointed. In 1934 the visit of Bowley and Robertson gave a fillip to the organisation of economic and statistical surveys. The Institute conducted a survey of rural indebtedness in 1934-35 a sample survey of consumer preference in 1935-36 and an extensive survey of handloom industries in 1936-37, a sample survey of agricultural crops in 1937, a survey of family budgets (1938-39) and an extensive work on crop-cutting experiments (1939). The Board of Economic Enquiry began to work in close collaboration with the Institute. The newly established Indian Central Jute Committee initiated an exploratory sample survey of Jute in 1937 under the technical guidance of the institute.

In January 1938 the first Indian Statistical Conference was held in Calcutta with R.A. Fisher as the president and had immediate promotional value. During the next five years similar conferences were organized at the same place and usually at the same time as the annual session of the Indian Science Congress. The science congress authorities agreed to start a separate section for mathematics and statistics from 1942 and a separate section for Statistics from 1945.

The Bowley-Robertson Committee constituted in 1934 to enquire into the feasibility of an economic census of the country recommended a census of production. It also recommended the co-ordination of central and provincial statistics and the setting-up of an economic intelligence organisation under an Economic Adviser. In 1938 was created an office of the Economic Adviser to the Government of India and the Statistics Research Bureau (created in 1933 for analysis and interpretation of economic statistics) was merged with it. This organ tendered advice on economic welfare, wholesale and retail prices and their index numbers. In 1944 the Council of Sceintific and Industrial Research appointed a committee on statistics, standardisation and Quality Control. On its recommendation came into being the Indian Standards Institution in 1945. In 1945 the Government of India set-up an inter departmental committee with the Economic Adviser as chairman to consider the available statistical material and made recommendations for filling in the gaps and improving upon the existing organization by way of decentralisation of primary responsibility

* SQC—Statistical Quality Control

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for departmental statistics coupled with the formation of central statistical office for co-ordination and by instituting a statistical cadre. The Gregory Committee set-up in 1946 recommended the setting-up of statistical bureaus at the Headquarters of state governments and the preparation of over all statistics for the entire country. 'As an aid to the statutory collection of factory statistics the Industrial Statistics Act was passed in 1942. In 1945 the Directorate of Industrial Statistics came into being to conduct annual censuses of manufacture. The Labour Bureau was set-up at Simla for compiling cost of living index numbers and to conduct *ad hoc* family budget surveys.

Statistical workers of the Indian Council of Agricultural Research, those of the Institute of Plant Industry at Indore and those working under the provincial departments of Agriculture and animal husbandry were meeting since 1941 to organize a common platform for statisticians and agricultural researchers for the sake of promoting and co-ordinating applications of statistical methods to problems of agriculture, fishery, livestock, etc. On January 3, 1947 the Indian Society of Agricultural Statistics was established and the publication of the *Quarterly Journal of Agricultural Statistics* was started.

The Indian Statistical Institute and the Indian Council of Agricultural Research were for a long time the only two training centres for officers on deputation. In 1937-38 the universities of Madras and Mysore modernised their courses of study on statistics.

A full fledged postgraduate course in statistics was introduced for the first time in India in the University of Calcutta in 1941. Members of the teaching staff formed the Calcutta Statistical Association which has been running a bulletin containing valuable research papers. Two years later statistics both at the honours and pass level was introduced in the Calcutta University.

The same year the University of Madras introduced a two year postgraduate diploma course. In 1942 the Mysore University started a full fledged postgraduate course in statistics.

M.Sc. degree by research in statistics was started in the University of Travancore (now University of Kerala) in 1940 and a research bulletin was published by the University. In 1945 a full fledged department of statistics was started and teaching for M.Sc. degree by papers was introduced. A bureau of statistics set-up in the department to assist the government for collecting official statistics was later on developed into the state department of statistics.

At first, the organizing of statistics courses in the university curricula was mainly due to the hope and expectation that it would gradually find useful applications in the physical, biological and social sciences.

However, the earliest demand for trained statisticians, that gave

impetus to these courses, came from government departments. Besides containing routine procedure, of compilation and analysis of data, the courses considered as a discipline in applied mathematics, comprised mainly of the theory of errors, frequency curves and least square fit.

It was only after the postgraduate courses were started in the universities that the modern view of Statistics has come to be emphasized. After the second world war, work done in different countries became nearly available to all. The attainment of Independence by India threw open to Indian professors and workers in Statistics to come into close contact with the work done not only in UK but also in USA, the continent of Europe, USSR and other countries of the world.

The post independence period : 1947 and afterwards

With the dawn of independence the scope of teaching and research in statistics increased to a great extent, various national development schemes stimulated the application of statistical techniques to researches in various branches of science and technology and to problems of national planning.

In 1949 a statistical unit was set-up in the Cabinet Secretariat. This expanded gradually and developed in 1951 May into the present Central Statistical Organisation for bringing about co-ordination of activities of various statistical agencies in the central government and of statistical bureaus which were being set-up in all the states for similar co-ordination at the state level. An important landmark in the collection, analysis and reporting agricultural and related statistics was the setting-up of the Directorate of Economics and Statistics in the Ministry of Food and Agriculture in 1948 for collection and publication of data on land utilization crop production, plantation, agricultural prices and wages and other agricultural compaigns.

In 1949 the Census Act was made permanent and the Office of the Registrar General was created as a permanent post and plans were worked out by this office evolving an integrated system of demographic and vital statistics on a continuous basis. The Government of India set-up the National Income Committee in 1949-50.

A successful conference on SQC was arranged in Calcutta under the joint auspices of the Indian Statistical Institute and the Indian Standards Institution. Shewhart's visit (1947-48) and lectures created interest among both engineers and industrialists and led to the establishment of the Indian Society for Quality Control in 1984. The latter society has been running postgraduate courses on statistical quality control in collaboration with the department of statistics, Calcutta University.

Shortly afterwards, the statistical wing of the ICAR* was designated

* I.C.A.R.=Indian Council of Agricultural Research.

as the Institute of Agricultural Research Statistics. The Institute started a two year diploma course covering not only statistical theory but also agricultural topics. Since then the Institute has been conducting specialised courses on sampling techniques, design of experiments and genetical statistics in co-operation with the division of agricultural physics as also courses leading to Ph.D. degrees.

In 1952-53 a team of SQC experts sponsored by the UNTAA* visited India and conducted intensive training courses in SQC methods in different parts of the country in collaboration with the C.S.O.** The Institute had recommended in 1953 that the Government should take appropriate measures to initiate statistical quality control methods in Indian industries. In 1953 a Policy Advisory Committee for SQC was set-up.

In 1950 the Indian Statistical Institute actively collaborated with the International Statistical Education Centre in Calcutta under the sponsorship of the UNESCO. The institute acted as the host society for the 27th session of the International Statistical Institute and the International Statistical Conference at Delhi. The Conferenee held a three day session in Calcutta also.

The multipurpose NSS*** was established in 1950 in the Ministry of Finance for collecting data relating to all aspects of the national economy on a continuing basis and required by the National Income Committee, Planning Commission and various central ministries. The Directorate of NSS was transferred to the Cabinet Secretariat in 1957. Among *ad hoc* sampling organizations may be mentioned the All India Agricultural Enquiry (1949-50, 1950-51) and the Rural Credit Survey in 1941-52.

The University of Madras had facilities for teaching statistics as a subject in the B.A. (Hons.) mathematics course since 1922 and award of M.Sc. degree by thesis since 1931 ; however a full-fledged master's degree course in the subject was initiated only in 1949 in one of the constituent colleges. The university had however instituted a postgraduate two year diploma course in 1941.

The Universities of Bombay, Gauhati and Patna set-up separate departments in statistics in 1948.

A number of other universities viz., Banaras, Delhi, Poona, Andhra, Karnatak, Baroda etc., started teaching statistics from 1950 onwards. A complete list of the universities which now offer courses in statistics at undergraduate/postgraduate levels may be seen in appendix II.

The All-India Institute of Hygiene and Public Health, Calcutta has carried out research involving the application of statistical techniques to

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* U.N.T.A.A.—United Nations Technical Advisory Association.
** C.S.O.—Central Statistical Organisation.
*** N.S.S.—National Sample Survey.

the fields of demography, public health and biological assay. In particular studies relating to growth and structure of population, changes in birth rate and mortality rate, disease incidence, estimation of the number of organisms and related problems have been made.

The Central Statistical Organization, New Delhi has conducted various studies and statistical enquiries relating to the economic problems of this country. Among these are problems of production, consumer expenditure, national income, capital formation and growth of economy, planning and programming and diverse other topics.

The Demographic Training and Research Centre, Bombay and various other centres have also been working on various demographic problems.

The Forest Research Institute, Dehradun has made some statistical investigations in the fields of forestry, entomology and agriculture, particular attention being paid to problems of forest sampling, classification and problems of locust swarming.

The Gokhale Institute of Politics and Economics, Poona has also carried out some applied statistical work relating to educational and demographic fields.

The Indian Meteorological Department, Poona has applied diverse statistical techniques in a very wide range of problems relating to meteorology and geophysics. These applications include among other things studies relating to seasonal forcasting relationship between climatic and geographical factors crop production and weather, rain fall analysis and studies on variation in magnetic fields and geomagnetic tides.

The Indian Standards Institution, New Delhi has endeavoured ever since its inception to introduce statistical concepts and techniques in the Indian Standards and through them to the industries. In particular, mention may be made of its work on evolving suitable sampling inspection plans, methods of sampling from bulk materials, introduction of quality control techniques in certification marking, and various other problems of industry.

The Indian Statistical Institute, Calcutta besides carrying out theoretical research work, has also organized quite a number of Statistical enquiries in the fields of biometry, demography economics and planning, anthropometry and agriculture. These cover a wide range of problems, and the related theoretical developments have already been referred to in the previous sections.

The Institute of Agricultural Research Statistics, New Delhi has carried out a variety of applied work in the fields of agriculture and animal husbandry.

The Labour Bureau, Ministry of Labour and Employment, Simla, has

undertaken several statistical studies on various problems of labour. Among these may be mentioned problems relating to the valuation of cost of living, survey of labour conditions and labour productivity.

The Department of Statistics, Reserve Bank of India has conducted statistical studies regarding various problems of finance and trade. In particular, problems relating to India's foreign trade in diverse commodities, industrial production, and problems of input and output have been given special attention by it.

During the last ten years, M.A./M.Sc. (Statistics) courses in India are undergoing changes so as to make the treatment of the subject mathematically more rigorous than before, especially in respect of the treatment of its foundations. Again, due to the increasing demand for trained statisticians in the applied fields like industry, agriculture, management etc., the universities are introducing applied subjects in their curriculum. The third feature entering into the picture is computing science which also leans to a considerable extent on modern mathematics for its base and has a great utility in a variety of fields where statistics is applied.

Thus the universities are now on the threshold of having to make judicious decisions as to the proportions in which modern abstract mathematical basis of statistics, the main body of the subject itself, applied statistics, and computer science have all to be blended in the university curriculum at the undergraduate and postgraduate levels.

REVIEW OF EXISTING ARRANGEMENT FOR TEACHING/RESEARCH IN STATISTICS

Statistics is being taught at three levels in the universities/colleges. These are :

(*i*) As a subject/paper at the undergraduate level (pass/honours)

(*ii*) As a subject/paper at the postgraduate level

(*iii*) As a diploma or certificate course.

Undergraduate level

At the undergraduate level statistics can be offered as a principal subject with one or two subsidiary subjects like mathematics, economics etc. It can also be offered as a subsidiary subject at the undergraduate level with another subject usually (mathematics or economics) as major, or along with one or two other subjects of equal standard. In particular the subject is taught in the following courses :

(a) B.A./B.Sc. (Hons.) with statistics principal

(b) B.A./B.Sc. (Hons.) with mathematics principal and statistics subsidiary

(c) B.A./B.Sc. (Hons.) with economics principal and statistics subsidiary

(d) B.A./B.Sc. (Hons.) with psychology principal and statistics subsidiary

(e) B.A./B.Sc. (Pass) with statistics and one or two other subjects of equal standard viz., economics mathematics or psychology

(f) B.A./B.Sc. (Maths.) as a paper

(g) B. Com. (Pass & Hons.)

(h) B.Sc. (Agriculture)

(i) B.Sc. (Engineering)

(j) B.Ed.

Teaching at the undergraduate level is done not only in some of the university departments but also in a number of affiliated colleges.

Postgraduate level

At the postgraduate level facilities are available for pursuing a master's degree course in Statistics or offer a paper or two in statistics as part of the M.Sc. (Mathematics) or M.A. (Economics/Psychology) course. Provision for teaching the subject at the postgraduate level is there in the faculties of commerce, agriculture, education and engineering.

Teaching of the subject at the Master's level is done mostly in the university departments but there are some affiliated colleges which have facilities for teaching at the M.A./MSc. level. A list of such colleges is given later.

Diploma/certificate course in statistics

A few universities are running a diploma course in Statistics in addition to their degree programmes. Ordinarily the minimum qualification for admission to the diploma course is a bachelor's degree.

For obtaining complete information about the existing physical facilities in the university departments of Statistics affiliated colleges which had provision for teaching upto the postgraduate level, a detailed questionnaire was circulated. A copy of the questionnaire may please be seen at appendix I. Based on the material received, an account of the existing facilities for teaching/research in the subject of Statistics in the various university departments is given below :

(a) University departments of statistics*

Calcutta University—1941

The first university to start an independent postgraduate course in Statistics was the University of Calcutta in the year 1941. There is no undergraduate teaching in the department. This is being done in four affiliated colleges of the university.

The department has been training a large number of students at the postgraduate level year after year and has also facilities for research in a wide variety of fields like : (i) mathematical statistics; (ii) design and analysis of experiments ; (iii) sample surveys: (iv) economic statistics; (v) demography; (vi) industrial statistics and (vii) psychometry.

The department makes use of the facilities in the central library which is adequately equipped in respect of both books and journals; in addition to adequate facilities for practical work, there is also a mechanical tabulation unit attached.

* The University departments have been presented in a chronological order according to the year from which postgraduate instruction started.

The department undertakes specific surveys/projects in collaboration with other departments/industrial units (private/government) from time to time. The department also renders active assistance and useful advice to other departments of the university in addition to large number of individuals and institutions associated with the subject.

Mysore University—1942

Postgraduate instruction in the subject of Statistics started in the year 1942 in the Maharaja's College, Mysore which is now a constituent college of the University. As a result of reorganization all the postgraduate departments of the university have been now transferred to a separate unit entitled 'Manas Gangotri' where the department of Statistics is also located. Postgraduate as well as research work is done in the department. Research facilities exist mainly in the following three topics : (i) statistical inference; (ii) stochastic processes; and (iii) probability theory.

The main university library is adequately equipped with books and journals in Statistics. Facilities for practical work are also adequate.

Teachers/research workers of other departments viz., economics, zoology and geography have informal consultations with the staff of the statistics department in regard to their problems under investigation. The staff of the department also participate in undergraduate teaching in one of the constituent colleges where there is provision for offering statistics as a subject at the first degree level.

Kerala University—1945

The University of Kerala established a separate department of statistics in 1945 for postgraduate and research work. The department is now running a postgraduate M.Sc. course in statistics, a postgraduate M.Sc. course in demography and a certificate course (evening) of one year's duration in statistics in collaboration with the Indian Statistical Institute, Calcutta. Facilities for research are provided in a number of fields mainly, probability, stochastic processes, inference, multivariate analysis, design of experiments, demography and operations research.

There is a separate departmental library which is adequately equipped in respect of both books and journals. The department is very well equipped for practical works. There is a good mechanical tabulation unit attached to the department.

In addition to its main programme of postgraduate instruction and research in statistics/demography, the department also performs, the following teaching/advisory functions :

    (a) providing instruction in statistics to students in M.A. (Economics), M.A. (Psychology) and M.Sc. (Botany) students of the university;

    (b) Analysing data collected by other departments in the university;

(c) assisting other departments of the university in connection with design of experiments and surveys undertaken by them;

(d) collecting and compiling educational statistics of institutions affiliated to the university; and

(e) conducting a one year (evening) certificate course in statistics in collaboration with the Indian Statistical Institution, Calcutta.

Bombay University—1948

A separate department of statistics was established in the year 1948 with facilities for postgraduate and research work. There is no undergraduate teaching in the department. Research facilities are provided in the following fields, viz., (i) design of experiments; (ii) operational research; (iii) sampling techniques; (iv) non-parametric inference; and (v) bayesian inference.

There is no separate departmental library but the department can draw upon the facilities in the university library which is adequately equipped in respect of both books and journals. Apart from adequate facilities for practical work there is a mechanical tabulation unit attached. The department also undertakes special survey and project in collaboration with other departments in the government or university from time to time.

The university has an electronic data processing centre housed in the same building as the department of statistics and the centre is being utilized by the departmnet for its survey/research work.

Patna University—1948

The department of statistics was set-up in the year 1948 and has facilities for both undergraduate/postgraduate instruction. The department also provides facilitiee for research in mathematical statistics, design of experiments, econometrics and demography. There is a separate departmental library, with an adequate number of books and journals; adequate facilities exist for practical work. There is also a mechanical tabulation unit attached to the department.

The department provides facilities for computation and analysis of data, collected by the research scholars, and workers of other faculties in the university and sometimes from other universities within the state.

The department also undertakes computation/tabulation work given by the statistical department of the Bihar State Government. A demographic research centre is also maintained by the department and the centre prepares various kinds of demographical reports relating to the State of Bihar from time to time.

Madras University—1949

A fulfledged postgraduate department with facilities for instruction upto master's level in the subject was set-up in the university in the year

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1949. A postgraduate diploma course in statistics is being run by the university since 1941. The M.Sc. programme in statistics is done on an inter-collegiate basis in collaboration with the university department. At present only the Presidency College in Madras is enrolling students for the M.Sc. course in statistics.

There is no separate departmental library. The main university library is adequately equipped with both books and journals in statistics. The department provides facilities for practical work.

Research workers in other disciplines viz., social, physical and natural sciences, consult the staff of the statistics department from time to time in connection with the analysis of their data.

Gauhati University—1949

A combined department of mathematics and statistics was established in the year 1948 with facilities for undergraduate teaching in statistics. Postgraduate courses were started in 1949. In 1956, the undergraduate programme was, however, discontinued and the department at present does only postgraduate teaching and also provides facilities for research in the following fields, viz., (i) stochastic processes; (ii) sampling distribution; and (iii) demography.

Undergraduate teaching is being done at present in some of the affiliated colleges. The department also runs a diploma course in statistics mainly for teachers and research workers of the university.

There is a separate departmental library; in addition the existing facilities in the main library, in respect of statistics books and journals, are also being used. Adequate facilities for practical work also exist. The department renders service to members of staff of other departments mainly agriculture, botany, anthropology in data analysis and experimental designs.

Lucknow University—1950

Postgraduate teaching in statistics was started in 1950-51 in the department of mathematics. A separate department of statistics was set-up in 1956; both undergraduate as well as postgraduate teaching is done in the department. Facilities for research are provided in two fields, viz. (i) Stochastic processes; and (ii) Statistical Inference.

Library and laboratory facilities are adequate. The members of staff of the department offer consultation service to research workers/staff of other disciplines in the university.

Andhra University—1951

A separate department of statistics was set-up in the Andhra University in July 1951. In addition to the master's programme (of three

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years duration) in statistics, the department also provides research facilities in stochastic processes, operational research and probability. The department also undertakes the teaching of statistics for M.A. (Economics) students. A one-year part time evening postgraduate diploma course in appled statistics was started by the department recently for the benefit of research workers in other science and social science departments.

The department has a separate library and has fairly adequate facilities for practical work. The department also offers technical advice to research workers of other departments.

There is no teaching at the undergraduate level in the department; provision exists for teaching the subject at the first degree level in some of the affiliated colleges along with mathematics.

Karnatak University—1951

A separate department for statistics was set-up in the year 1951 in the faculty of science. The department has provision for postgraduate instruction and research. No undergraduate work is being done. The topics for which research facilities exist are statistical inference, stochastic processes and sampling. There is no separate departmental library. The main library is adequately equipped with books on statistics. The department is also subscribing to a number of journals both Indian and foreign. Facilities for practical work are adequate. A separate mechanical tabulation unit is also attached to the department.

In addition to postgraduate teaching and research, the department also renders service in the following two directions, viz., (i) by organizing courses on elementary statistics for the benefit of students of the postgraduate departments of Sociology, Social Welfare and Economics; and (ii) by undertaking tabulation of data of research projects conducted by university teachers on behalf of government agencies like NCERT etc.

M.S. University of Baroda—1953

The department of statistics was started in the M. S. University of Baroda in 1950 with teaching of statistics in B. Com., and M. A./M.Sc. (Mathematics) course. B.Sc (Statistics) principal course was introduced in June 1951 and M.Sc. in statistics in June 1953. Subsequently teaching of the subject in other faculties also commenced. The department undertakes undergraduate as well as postgraduate teaching work in the subject not only for students who offer Statistics as a principal subject but also for students of other departments including professional courses (like engineering, textile etc.) for whom statistics is a subsidiary subject. Facilities for research are provided in distribution theory, design of experiments statistical quality control, educational statistics and demography.

The department depends for its supply of books and journal on the central library which is well equipped.

Adequate facilities including a mechanical tabulation unit also exist for practical work.

The department maintains a statistical service unit for assisting research workers of other disciplines in the statistical aspects of their problems, classification of data with the help of the mechanical tabulation unit etc. Courses in statistics are also given by the department for the benefit of staff, research scholars of other disciplines. The department has also undertaken studies on specific topics like wastage stagnation in university, measurement of infant-mortality etc.

Poona University—1953

There is a combined department of mathematics/statistics attached to the faculty of science; the teaching of statistics commenced in August 1953. The department does postgraduate work and supervises undergraduate teaching work in the constituent and affiliated colleges. Facilities for research are also provided in statistical inference, probability, non-parametric methods, stochastic processes, multivariate analysis and operation research.

The department depends for its supply of books and journals on the main university library, which is adequately equipped. Facilities for practical work are adequate. There is a mechanical tabulation unit attached to the department.

The department maintains a statistical service unit. This unit provides statistical advice, guidance and facilities for data analysis to the research workers in other physical, biological and social sciences. The staff of the department also participate in the teaching of short courses in statistics included in the syllabi of other science courses.

Gujarat University—1955

Postgraduate courses in statistics were started in 1955 in a separate section attached to the University School of Social Sciences. The section is now part of the mathematics department in the faculty of science and provides only postgraduate instruction; there are facilities for research in multivariate analysis and statistical inference.

There is no separate departmental library but the main university library is adequately equipped with important statistical books and journals. Adequate facilities for practical work are also there. The department renders assistance by way of statistical analysis, data processing, analysis of designs, to other departments of the university viz., labour welfare, economics and sociology. Students of the commerce faculty at the postgraduate level also take the help of thes tatistics department.

Agra University—1956

The Institute of Social Sciences which is a constituent unit of the Agra University has facilities for training in statistics at the master's level

and also provides facilities for research. The institute trains students for the M. Stat. degree of the Agra University and the course is of two years duration. The main field of specialization in which work is being done is sample surveys. The Institute has adequate library/laboratory facilities and a mechanical tabulation unit is also attached. The staff of the institute collaborate with the research students of the local Medical College in constructing designs and analysis of data. The Institute's staff also help in teaching statistics to the students of M.S.W. (Master of Social Work) course and the diploma course in research methodology.

There is no undergraduate teaching in the institute; some of the affiliated colleges of Agra University have facilities for instruction at the undergraduate level.

Aligarh Muslim University—1956

The combined department of mathematics/statistics of the Aligarh University started instruction in the subject of statistics at the undergraduate level in 1954 and at the postgraduate level in 1956. A diploma course in statistics was also instituted in the year 1956.

There is a combined library for mathematics and statistics. The department has adequate facilities for practical work. The main field in which research work is going on is 'statistical inference'.

Delhi University—1957

Postgraduate course in statistics was started in the year 1957. There is a combined department of mathematics and statistics in the university. The department provides postgraduate instruction in the subject and also provides facilities for research in the following fields viz., stochastic processes and statistical aspects of operational research. The subject can also be offered at the subsidiary level in the B.A. (Hons.)/B.Sc. (Hons. (Mathematics/Physics/Economics) courses and the teaching is done in the constituent colleges. Statistics is also taught as a paper for (i) B.A. (Pass) and B.Sc. (General), (ii) B.A. (Hons.)/B.Sc. (Hons.) (Mathematics), (iii) M. A./M.Sc. (Mathematics) and (iv) M. A./M.Sc. (Operational Research).

There is no separate department library but the department depends for its supply of books on the central library which is adequately equipped. Regarding journals the position needs improvement. Adequate facilities exist for practical work. There is no separate mechanical tabulation unit attached to the department.

Bhagalpur University—1958

A separate department for statistics was established in the year 1958. The department imparts instruction only at the postgraduate level and facilities for research are being developeu. At the undergraduate level the subject is being taught in one of the affiliated colleges.

The existing library facilities need strengthening in order to make the department obtain more benefit from the latest literature available in the

various fields of Statistics. Laboratory facilities exist for practical work.

The department assists research workers in other disciplines in formulating suitable statistical designs, applying proper statistical techniques and drawing inferences.

Utkal University—1958

There is a separate department of statistics in the Utkal University and was set-up in the year 1958. The department is concerned with only postgraduate teaching. Teaching at the undergraduate level is done in one of the affiliated colleges. Research facilities are also provided in the fields of (i) estimation and testing of hypotheses; (ii) combinatorial analysis; and (iii) non-parametric inference.

The department has a separate library with adequate supply of books and journals. Facilities for practical work are adequate. The department also provides instruction in statistics at subsidiary level to students of other departments viz., mathematics, applied economics and anthropology.

Annamalai University—1959

The department of statistics was established in 1954. The B.A. (Statistics) course started functioning from the academic year 1954-55. This was, however, discontinued in 1958-59 and the same year the B.Sc. (Statistics) (Main)—three-year course was started. The M.Sc. two-year degree course in Statistics started functioning from the academic year 1959-60.

The subject is also taught at a subsidiary level in other courses leading to the bachelor's degree in commerce, agriculture and also to students of economics, psychology and mathematics.

At the postgraduate level the subject can be offered at the principal level for the Master's degree course in Statistics. It is also taught at the subsidiary level for M.A. (Economics), M.Sc. (Zoology) students.

The department also provide research facilities mainly in the fields of distribution, designs and probability.

There is a separate departmental library which is equipped adequately in respect of both books and journals. The department has adequate facilities for practical work, and collaborates with research workers of other disciplines in applying suitable statistical techniques to various practical problems.

Osmania University—1959

Postgraduate teaching in statistics started in the university in the year 1959 with facilities for both undergraduate as well as postgraduate teaching.

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A separate department was set-up in the year 1966. The department provides research facilities in statistical inference. There is a separate departmental library with adequate books and journals. Facilities for practical work are adequate. The department maintains collaboration with teaching/research personnel of other departments from time to time. Occasionally a course of lectures is also organized by the department for the benefit of research workers in other disciplines.

Rajasthan University—1961

The department of statistics set-up in the year 1961 does both undergraduate as well as postgraduate teaching and also provides facilities for research in sample surveys and demography. There is no separate departmental library. The main library of the university is equipped adequately with books and journals in statistics. Facilities for practical work are adequate. The department provides assistance to staff research workers of other departments. mainly sociology para-psychology, adult-education and economics.

Sardar Patel University—1961

The department of statistics set-up in the year 1961 in the Sardar Patel University is a part of the combined department of mathematics and statistics and is concerned with only postgraduate teaching and research. The undergraduate teaching is done in some of the local colleges. There is no separate departmental library but the main library is equipped with important books and journals in statistics. Adequate facilities are there for practical work.

Vikram University—1961

The department of statistics set-up in the year 1961 is a part of the mathematics department in the faculty of science. Only postgraduate work is being done in the department. Teaching at the undergraduate level is done in two of the affiliated colleges. Facilities for research are provided in 'statistical inference' as applied to incompletely specified models.

Banaras Hindu University—1962

There is a combined department of mathematics and statistics and facilities for instruction in the subject at the undergraduate level started from the session 1950-51. The postgraduate programme started from the year 1962. The department has also been running a diploma course in Statistics since 1950-51.

The department has a well equipped library with important journals and books, it has also good facilities for practical work; a mechanical tabulation unit is attached to the department. Facilities for research are available in the following fields : (i) applied probability; (ii) demography; (iii) estimation; and (iv) design of experiments. The diploma

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course run by the department is mainly intended for research students and teachers of other departments of the university and the course is of elementary level.

Sri Venkateswara University—1962

The department of statistics in the Sri Venkateswara University does both undergraduate as well as postgraduate teaching and in addition provides facilities for research. The topics on which research work is being done at present are : (i) estimation theory; (ii) linear programming; and (iii) non-parametric inference.

There is no separate departmental library but the university library is well equipped with important journals and books. Facilities for practical work are adequate.

The department maintains collaboration with staff members/research workers of other disciplines, like botany, zoology, geology, economics, psychology for statistical analysis of data collected. The department also imparts instruction in ancillary statistics to M.Sc. (Previous) zoology students.

Panjab University—1966

The department of statistics is part of the centre of advanced study in mathematics. The department does only postgraduate teaching and also provides facilities for research in : (i) non-parametric methods ; (ii) multivariate analysis; (iii) sampling; (iv) design of experiments; (v) statistical quality control; and (vi) probability.

There is a separate departmental library with adequate number of books and journals. Laboratory facilities are also adequate.

In addition to postgraduate teaching and research, the department also performs the following functions :

(a) Teaching statistics courses to students of B.Sc. (Hons.) School in economics, geology, chemistry, physics and bio-sciences.

(b) Guiding research students of other departments in statistics.

Punjabi University—1966

The teaching of Statistics is done by the department of mathematics of the university which prepares students for M.Sc. in mathematics with specialization in statistics. The question of changing this title to M.Sc. degree in statistics is under the consideration of the university.

The department does only postgraduate teaching and provides facilities for research in 'sampling theory' and 'non-parametric inference'.

Both library and laboratory facilities are being developed.

Dibrugarh University—1967

A separate department of statistics was set-up only in the year 1967. The department at present offers a two year postgraduate course in statistics. Research facilities are yet to be developed. There is no undergraduate teaching in the department but facilities exist for teaching the subject at the undergraduate level in two affiliated colleges. Being a newly started department both library as well as laboratory facilities are still in the stage of development.

Allahabad University—1968

The University has started from the 1968-69 session, courses in statistics both at the undergraduate and postgraduate levels; in the department of mathematics. A separate department has not yet been set-up.

Bangalore University—1969

The University proposes to institute a postgraduate degree course in statistics from 1969-70.

(b) Universities having provision for teaching the subject up to postgraduate level in the affiliated colleges.

Kanpur University

Only one college, viz., D.A.V. College, Kanpur affiliated to Kanpur University is providing instruction up to the postgraduate level at present.

Kerala University

The following colleges affiliated to Kerala University have provision for teaching the subject of statistics up to the postgraduate level. These are :—

(*i*) Government Victoria College, Paighat

(*ii*) St. Thomas College, Palai

Madras University

The Presidency College, Madras is teaching the subject up to the postgraduate level in collaboration with the university department of statistics.

Meerut University

The following five colleges affiliated to Meerut University have facilities for instruction in statistics up to the master's level. These are :—

(*i*) D.A.V. College, Muzaffarnagar

(*ii*) D.A.V. College, Dehradun

(iii) Janta Vedic College, Baraut

(iv) Meerut College, Meerut

(v) M.M. College, Modinagar

Nagpur University

The College of Science, Nagpur is the only affiliated college under the jurisdiction of this university having provision for teaching the subject of statistics up to the postgraduate level.

South Gujarat University

Two Colleges, viz. (i) Navyug College of Arts and Science, Surat; and (ii) V.S. Patel Arts and Science College, Billimora, provide instruction up to M.A./M.Sc. level in the subject of statistics.

Statistics of enrolment and staff in the postgraduate affiliated colleges are given in appendix III(b).

(c) Institutions deemed as universities

Gujarat Vidyapith which is an institution deemed as university, has provision for teaching statistics at the undergraduate level.

(d) Other institutions

Both the Indian Statistical Institute, Calcutta and the Institute of Agricultural Research Statistics, New Delhi have facilities for training as well as research in statistics. The details are as under :

Indian Statistical Institute

The Indian Statistical Institute runs a number of courses, some leading to a degree and others leading to a diploma/certificate; in addition, the institute also runs a number of 'specialized courses' and of 'short durations' intended for persons in employment.

The activities of the Institute relating to the imparting of education, training and research facilities, and the conduct of all-India examinations are summarised below :

A. COURSES

1. COURSES LEADING TO DEGREE IN STATISTICS

S. No.	Degree	Duration of course
1.1	Bachelor of Statistics (B. Stat.)	4 years
1.2	Master of Statistics (M. Stat.)	2 years
1.3	Doctor of Philosophy (Ph. D.) (Residential course preparatory to Ph. D.)	18 months

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2. SPECIALIZED COURSES IN APPLIED STATISTICS LEADING TO DIPLOMAS

S. No.	Course	Duration
2.1	Demography	1 year
2.2	Econometrics and planning	1 year
2.3	Large scale sample surveys	1 year
2.4	Operations research and allied techniques	1 year
2.5	Statistical quality control and allied techniques	1 year
2.6	Other subjects	1 year

3. SUMMER COURSE IN STATISTICS

Syllabus and duration of the course is decided before the commencement of the course each year.

4. COURSES IN STATISTICS FOR PERSONS IN EMPLOYMENT

S. No.	Course	Duration
4.1	Statistical officers' training course (jointly with CSO)	6 months
4.2	Specialization courses for statistical officers (jointly with CSO)	3 months
4.3	Special short-duration individual training for officers on deputation	—
4.4	Occasional short-duration course on special subjects	—

5. EVENING COURSES

S. No.	Course	Duration
5.1	Statistical methods and application	1 year
	—Bangalore	
	—Bombay	
	—Calcutta	
	—Delhi (in collaboration with CSO)	
	—Hyderabad (in collaboration with Indian Institute of Economics)	
	—Madras	

S. No.	Course	Duration
	Trivandrum (in collaboration with Kerala University)	
5.2	Elementary techniques of computations	6 months
5.3	Statistical computation	6 months

6. ELECTRONIC COMPUTER COURSES

S. No.	Course	Duration
6.1	Automatic data processing systems	1 year
6.2	Intensive course on programming and applications	3 months
6.3	Diploma in computer science	1 year

7. COURSES AT THE INTERNATIONAL STATISTICAL EDUCATION CENTRE

S. No.	Course	Duration
7.1	Regular course in statistics	10 months
7.2	Specialisation courses for individuals	—
7.3	Research and advanced studies for visiting senior statisticians	—

8. DOCUMENTATION TRAINING COURSE AT BANGALORE OF ONE YEAR DURATION

9. Besides the above courses, facilities are provided for advanced study and research in statistics, mathematics, economics and other social and natural sciences for qualified persons who may be offered research fellowships.

10. In addition to the above courses, occasional short courses of duration 12 weeks or less are held in computer application, statistical quality control, operations, research and other subjects.

B. OPEN PROFESSIONAL EXAMINATION

The following diplomas and certificates are awarded on the basis of all-India examinations, open to external candidates :

(i) Statistical field survey junior certificate

    (*ii*) Statistical field senior certificate

   (*iii*) Statistical field survey diploma

   (*iv*) Computer's certificate

    (*v*) Punched card machine operator's certificate

   (*vi*) Punched card data processing diploma

  (*vii*) Statistician's diploma

 (*viii*) Associateship of the Indian Statistical Institute (AISI) on the basis of report submitted of professional work

   (*ix*) Associate Fellowship of the Indian Statistical Institute (AFISI) on the basis of report/thesis submitted of professional work.

C. AWARD FOR OUTSTANDING CONTRIBUTION

The degree of Doctor of Science (D.Sc.) is awarded in recognition of outstanding published work in the field of Statistics.

Institute of Agricultural Research Statistics

The Institute of Agricultural Research Statistics has been providing facilities for research as well as training in various branches of applied statistics as related to agriculture and animal husbandry for a number of years and has trained a large number of agricultural workers as well as professional statisticians in the field of agricultural statistics.

The following courses are run in the institute :

  (*a*) A master's degree course in agricultural statistics

  (*b*) Senior certificate course

  (*c*) Professional statistician's certificate

  (*d*) Junior certificate course

In addition to the training courses referred to above, the institute also provides facilities for research in a number of fields, notably: (*i*) agronomy; (*ii*) sample surveys; (*iii*) design of experiments; (*iv*) statistical genetics; and (*v*) applied problems arising in agriculture and animal husbandry.

(*e*) *Indian Institutes of Technology*

The Indian Institutes of Technology at Bombay, Delhi, Kanpur, Kharagpur and Madras are not only giving courses in some of the branches of statistics but are also engaged in research work in statistics.

General Observations

Books and journals

Most of the university departments of statistics have replied that they are able to get an adequate supply of books and journals required for their routine use. Some universities, however, like, Aligarh, Andhra, Banaras, Bhagalpur, Mysore, Panjab and Sardar Patel have specifically

stated that the position so far as back volumes of journals are concerned needs to be improved. It might also be mentioned that certain university departments do not have separate departmental libraries. They depend on the central library for their supply of books and journals. The position in the affiliated colleges which have provision for teaching the subject at the postgraduate level needs to be improved.

Classroom accommodation

The replies from the universities/colleges on this aspect of physical facility do not conducively indicate the actual situation prevailing. Some universities, like, Annamalai, Gujarat, Aligarh, Patna doing postgraduate work have specifically indicated that they do not have sufficient classroom accommodation and the position needs improvement.

Equipment

The position in general is satisfactory. In quite a few universities, a separate mechanical, tabulation unit is also attached to the department. Appendix V gives the details i.e., the equipment facilities for mechanical tabulation in the universities.

Enrolment and staffing pattern

Appendix III (a) indicates the university-wise distribution of enrolment and staff-enrolment according to undergraduate/postgraduate and research levels and staff according to designation. At the postgraduate level (including both previous and final) the number of students varies generally between 15 and 60. The number of research students fluctuates between 1 and 15. In certain universities undergraduate teaching is also done by the university departments.

As regards the staffing pattern it might be mentioned that the total number of teachers including tutors, demonstrators fluctuates between 3 and 18. The overall position regarding the 'staff' cannot be said to be satisfactory. The posts of 'professors' in some universities were found lying vacant for different periods of time. Secondly where university departments are doing both undergraduate as well as postgraduate teaching, the teaching load is rather heavy thereby giving little time to the university professors/readers for undertaking independent research or guiding research students.

Research projects/surveys

A list of the research projects/surveys which were undertaken by the university departments during the last three years is given in Appendix VI.

Collaboration with research workers of other departments

Though active collaboration exists between certain university departments and research workers/staff of other departments, within the same university, the overall position cannot be said to be satisfactory. A

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suitable machinery has to be created by which it becomes possible for the department of statistics to play a more effective role in rendering useful service/advice in fields like design of experiments, data processing, computer techniques and organization of short-term courses in applied statistics for the benefit of research workers and staff of other departments.

Entry requirements at the master's level

The minimum qualification for admission to the Master's degree course in Statistics is a Bachelor's degree with either Statistics or Mathematics as a subject. It might be mentioned here that teaching of the subject at the undergraduate level (pass or honours) is not as widely spread as it ought to have been. Even now there are quite a few universities where there is no provision at present for teaching the subject at the undergraduate level. This is really a handicap which is to be eliminated as early as possible. Some training in the subject at the undergraduate level is essential before the students take up a full-fledged two year master's degree course in statistics.

Level of teaching—Undergraduate

The level of teaching of statistics at the undergraduate stage in different universities is very uneven. In arts and science faculties, only a few universities, offer the course as a main subject for study. Several universities, arrange for one paper in elementary statistical methods, and a few an additional paper on applied statistics including official statistics, economic statistics and occasionally statistical quality control methods.

Level of teaching—Postgraduate

These different practices make it difficult to plan a uniform syllabus of a fairly high standard at M.A./M.Sc. level. Further in admission to M.A./M.Sc. courses a high percentage of students come from mathematics course without any background in statistics. Naturally the teaching should start from elementary as well as fundamental methods, leaving little time for teaching advanced courses. This explains the great variation in the syllabi of M.A./M.Sc. courses in different universities. Hence, for future requirements, if courses of a fairly high standard are to be planned for M.A./M.Sc., preparatory courses should be given at the undergraduate level and admissions to M.A./M.Sc. courses should be restricted to students who were exposed to these courses at the B.A./B.Sc. level. Further at the M.A./M.Sc. level in addition to the teaching of the core of statistical methods, provision should be made for specialisation depending upon the background of the students and the requirements of the other branches. Most of these students may take up to teaching of statistics in one of the faculties, or work in various applied fields like government administration or research divisions in government, industry, trade and commerce, apart from agriculture, technology and other sciences. Such specialists should have some basic knowledge of the field of application and should be taught advanced methods which are applicable in the respective fields. At this level the requirements of mathematical knowledge

at a higher level may become paramount and provision should be made to teach these courses.

Teaching of applied statistics

Two other important considerations arise in this connection. Namely, whether these applied topics should be taught by a statistician who has adequate background of the field of application or by a specialist in the field who is capable of teaching the statistical methods. There is much to be said on either side and the choice depends upon the availability of personnel with the required knowledge of the field of applications as well of the appropriate statistical methods. The other important consideration is the provision of facilities for getting practical experience. It is often found that fresh students who were not entrusted with practical problems in administration, industry often find it difficult to correlate their theoretical knowledge with the problems of handling new data and application of appropriate methods of analysis to draw conclusions. The practicals they do in the classes are often taken out of text-books written by foreign authors who might have given illustrations from their own experience, even of antiquated data. Hence teacher may have to be provided with facilities to select appropriate current data from the country and the students also should be trained during the degree course or immediately after taking service in the practical experience of handling such data.

Statistics in economics and commerce courses

An additional problem arises in the case of students of economics and commerce courses. The present courses at undergraduate level are elementary. It may be noted that a large percentage of students of these courses should have given up mathematics at the secondary school stage. Hence to enable them to understand the advanced statistical methods, special courses in mathematics should be provided at the undergraduate level. Students who are weak in mathematics should not be eligible to take up statistics courses at higher level. Hence, through elementary statistical methods including collection of data, descriptive methods of pictorial representation, measures of central tendency, dispersion etc., may be taught to all students and advanced statistical methods applicable in econometrics programming and other techniques of business administration may be restricted to only students who take up the special courses in mathematics and advanced statistical methods.

Research

A uniform pattern cannot be suggested for provision of research facilities in different universities; as it depends on the availability of specialists in different branches of mathematical as well as applied statistics. However, after obtaining a master's degree, students who intend to take up research should be given one year preparatory training in the chosen and allied branches of study. Here again for students of mathematical statistics, the requirements of mathematics may be higher and for

applied statistics facilities for obtaining data in the branches in which the new techniques could be experimented should be found. In some cases facilities for the use of electronic computing may also be required.

At the level of postgraduate teaching and research another important consideration arises. The personnel who are incharge of research sections in administration, industry and trade are often too much engrossed in their day to day problems and do not find time to catch up with the latest developments in statistical methods of application. On the other side the academic research workers are not acquainted with the practical problems which await solution by new techniques. Hence a two way traffic between the workers in the practical operation fields and the academic teachers by part—time or even fulltime assignments for limited periods might be found fruitful. Further short term courses, seminars etc., to discuss problems of mutual interest might be arranged with advantage.

Statistics teaching at pre-degree level

Two other matters that require consideration are (i) the stage at which young men should be exposed to this science (ii) the teaching of auxiliary subjects whose knowledge is required for proper application of the method in an appropriate discipline. There is no doubt that a good foundation of mathematics is required at the different stages of teaching of mathematical statistics, degree as well as postgraduate courses. However, a general training in collecting and handling of data can be started even at the secondary and pre-university stage. But care has to be taken in instilling unfamiliar ideas, as any wrong impression made at this stage cannot be easily erased at a later stage. A good background of the subjects of application e.g., physical, natural and social sciences will be found useful. In former years statistics was taught mainly in science faculties (mathematics) and the students had to gain the required background in the field to which they were attached for service. There was handicap for students of economics in India, because, most of the students had poor background of mathematics and they could not follow the econometric methods which presume knowledge of mathematical economics and advanced statistical methods. On the other hand, mathematical statisticians could not progress much for want of the necessary economic background. To over come these difficulties an integrated course similar to professional courses e.g., engineering, medicine etc., has been suggested. In this course, the students have to study biological science, economics etc., to get the necessary background. This experiment is tried only in the Indian Statistical Institute. It is worthwhile considering whether this practice could be adopted on a wider scale.

PROPOSED SYLLABI

Introduction

The committee has examined the existing syllabi for the under-graduate and postgraduate courses and has subsequently prepared the syllabi indicating the extent of training prescribed at each level. The syllabi for B.A./B.Sc. and M.A./M.Sc. courses follow. It is desirable that these syllabi are reviewed and revised once in five years. The structure and syllabi of the courses indicate the broad outlines and the universities are free to modify the same according to their needs and the facilities available.

In most of the universities in India, the examination for the M.A./M.Sc. degree in statistics consists of two parts, at the end of one academic year each except in the universities of Calcutta, Bombay, Mysore and Utkal. In some universities like Aligarh, Banaras, Meerut and Poona each of the two academic years consist of two semesters each, so that, in all there are four semesters and an examination is conducted at the end of each semester. In all the universities where the examination consists of two parts, a candidate must secure minimum qualifying marks in the part I or the previous examination to be able to appear in the part II or the final examination. In each part the candidate must pass separately in theory and practicals. The minimum qualifying marks of the course vary widely from one university to the other. In all the universities the require-ment of marks for obtaining a first class is 60 per cent. In some universities students receiving marks in between minimum qualifying marks and 50 per cent are put in the third class and those obtaining marks in between 50 per cent and 60 per cent are credited in the second class but in some other universities students are credited in either the first class or the second. The aggregate marks, number of hours allotted to theoretical and practical papers, percentage of marks allotted to practical and also the distribution of marks over written examination, project work, viva-voce and practicals included in the practical examination vary widely from one university to another. The number of optional papers also varies from zero to two. The aggregate is different also. The duration of the examination in each theory paper is either three hours or four hours. But that for the practical varies widely according to marks allotted to each paper. Even for the allotment of 100 marks to a practical paper, the number of hours for the examination varies from three to nine. In all the universities marks for the practicals, include marks for practical record book and viva-voce and in some cases for project work. A few universities include dissertation also. In Bombay University unlike other universities M.Sc. degree may be obtained in two ways—by written examination covering theory and practical papers or by submitting a dissertation alone.

The review committee feels the examination both at the postgraduate

and undergraduate level should be held at least in two parts. If examined in two parts, the examination will be held approximately after 32 weeks of the commencement of the course. If semester system is adopted each semester term will work out to be approximately 10 to 15 weeks.

In recent years statistics received recognition as an independent discipline for teaching and research.

The importance of application of different techniques varies from branch to branch for example, the main emphasis in physical, natural and allied science is on methods relating to design of experiments and estimation of probable errors which are by and large of random nature. In social sciences including economics and commerce attention has to be paid to (i) the collection of data (primary/secondary) in large scale sample surveys, (ii) methods of summarizing the data and finding the correlations between various factors involved, and (iii) minimization of non sampling errors. Also, statistical quality control, operations research etc., are required. However, the core of the methods of estimation, testing of hypotheses, apart from descriptive analysis and sampling methods are required in all disciplines. In framing the syllabi attention is given mainly to the teaching of statistics as a primary discipline except in the case of economics and commerce where it comes as subsidiary discipline. A syllabus is given for a certificate course to serve as an ancilliary course for students and research workers in science subjects. We have not gone into the requirements of special courses for persons who opt for jobs of statisticians in the government and business management.

The new features of the proposed syllabi of study may be stated as follows :

1. Sufficient stress has been given on allied mathematical topics which are considered to be essential for learning mathematical statistics.

2. It is no doubt that different universities will have their own specializations but they should teach some common fundamental topics which are required for any work in statistics. This has been accomplished by introducing compulsory and optional groups both at M. Sc. and B. Sc. (Hons.) stages.

3. Courses in theoretical and applied topics have been revised by the inclusion of current topics. It is presumed that for each applied topic some introductory lectures (15 to 20) on the basis subject will be arranged in coordination with other departments.

4. The syllabi have been framed in terms of half papers. A half paper includes subject matter delivered on any topic in course of 35 to 40 lectures and is equal to three credit system.

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B.A./B.Sc. (Pass)

It is proposed that the B.A./B.Sc. (Pass) examination will be held in six compulsory half papers on theory and two half papers on practical. There will be no optional papers.

(i) Statistical methods—one half paper

Compilation, classification, tabulation and diagrammatical representation of various types of statistical data. Concepts of statistical population, random sample and frequency curve. Measures of location and dispersion. Concentration curve and coefficient of concentration. Moments, Sheppard's correction (without proof) for moments up to fourth order. Measures of skewness and kurtosis. Pearsonian system of frequency curves—empirical derivation of the differential equation, statement of the general properties of the simple types of curve. Smoothing of data—free hand method, method of moving averages, method of group averages, method of least squares, method of moments, fitting a polynomial or any curve reducible by suitable transformation to a polynomial. Measures of association and contingency. Correlation and regression involving two variables—correlation coefficient, regression coefficient and correlation ratio, rank correlation. Intraclass correlation. Linear regression involving more than two variables and corresponding partial and multiple correlation coefficients.

(ii) Probability and distributions—one half paper

Classical definition of probability. Theorems of total and compound probability. Repeated trials. Mathematical expectation theorems on the expectation of sum of random variables and product of independent random variables. Tchebycheff's Lemma, weak law of large numbers. Notion of probability in continuation. Binomial, Poisson, normal and rectangular distributions. Poisson and normal distributions as limiting forms of binomial distribution. Fitting of poisson, binomial and normal distributions to observed data and testing goodness of fit. Bivariate distribution: marginal and conditional distributions. Bivariate normal distribution. Simple formulae of interpolation and numerical integration.

(iii) Sampling theory and test of significance—one half paper

Statistical concepts of sampling distribution and standard error. Derivation of sampling distribution of the means of random sample drawn from normal population and χ^2 (sum of squres of normal deviates—characteristics of t and f distributions (without derivation).

Tests of significance—two kinds of error, power and unbiasedness of a test (definitions only).

Applications of small sample tests for a single mean, difference of two means, a single variance, ratio of two variances, regression coefficients, coeffiecent of correlation (simple, partial and multiple).

Elements of the theory of estimation—requirements of a good estimate unbiasedness, consistency, efficiency (in the large-sample sense) and sufficiency (definition only). Maximum likelihood estimates and statement of their properties. Concept of confidence interval.

Standard error, fomulae for mean, multinomial proportions, moments and quantiles. Formula for standard error of a function of statistics in large sample (without derivation) and its application for the standard deviation and coefficient of variation. Use of the above formulae and the formula for standard error of correlation coefficient in large sample tests.

Use of transformations to make the variance (in large samples) stable- log s and z—transformation of correlation coefficient.

Uses of Pearsonian/χ^2 for tests of independence, homogeneity and goodness of fit.

(iv) *Sampling techniques and design of experiments—one half paper*

Advantage of sampling method; requirements of a good sample. Simple random and stratified sampling. Definitions of systematic, multi-stage and double sampling. Forms and schedules for enquiry.

Basic principles of design—randomisation, replication and local control. Completely randomised arrangement, randomised block design and Latin Square design. Factorial experiment, its advantages, main effects and interactions in 2 factor and 2^3 experiments. Analysis of variance applied to the above designs. Analysis of covariance in one way classified data.

(v) *Educational and vital statistics—one half paper*

Percentile curves, percentile ranks and their uses. Combination and comparison of examination scores. Norms and scaling procedure. Construction and standardisation of mental tests. Intelligence quotient. Parallel tests. Reliability and validity of tests.

Methods and organizations of collection of vital statistics in India. Indian census. Measurement of mortality and standardisation of death rates. General description of a complete life table. Measurement of fertility and reproduction. Comparison of mortality and reproduction rates. Logistic curve for population growth and its fitting by three selected points and by Rhode's method.

(vi) *Economic and official statistics and statistical equality control—one half paper*

Construction and use of price index numbers and tests in connection with them. Chain index number. Cost of living index number. Construction of several index numbers currently used in India.

Analysis of time series—concepts of different components, determination of trend and seasonal indices by different methods.

Elementary notion and estimation of national income.

Advantages of statistical quality control, construction, use and interpretation of control charts for mean, range, fraction defective and

number of defects.   Single and double sampling inspection plans—concepts of producer's and consumer's risks, O.C.A., S.N. & A.O.Q. curves.

(*vii*) & (*viii*) *Practical—two half papers*

One half paper based on numerical analysis (interpolation and numerical integration), statistical methods and sampling theory and tests of significance.

A second half paper based on the remaining topics in the syllabus.

B.A./B.Sc. (Hons.)

The B.A./B.Sc. (Hons.) examination will be held in two groups (a) compulsory group and (b) optional group.   It is suggested that the following half papers may be considered in the compulsory group and the universities may choose other two half papers from the remaining portion of the list according to the resources available.   The compulsory group may consist of the following half papers.

(*i*) Basic mathematics
(*ii*) Numerical analysis
(*iii*) Probability
(*iv*) Statistical methods
(*v*) & (*vi*) Sampling theory and tests of significance
(*vii*) & (*viii*) Statistical inference
(*ix*) Sampling techniques
(*x*) Design of experiments

The optional group may consist of the following half papers from which two have to be selected.

(*i*) Economic statistics
(*ii*) Statistical quality control
(*iii*) Educational and psychological statistics
(*iv*) Vital statistics

In the compulsory group there will be three half papers in practical and in the optional group there will be only one half paper.   Practical papers will include *viva-voce* and internal assessment.

Detailed syllabi of the topics are being appended.

B.A./B.Sc. (Hons.) COMPULSORY GROUP

(*i*) *Basic Mathematics—one half paper*

MATRICES : Addition and multiplication of matrices : transpose and adjoint of a matrix, inverse of a square matrix; elementary matrices;

rank of a matrix and simple theorems thereon; solutions of homogeneous and non-homogenous linear equations; equivalent matrices and reduction of a matrix to semi-reduced and fully reduced equivalent forms ; orthogonal matrices, characteristic roots and vectors of a square matrix.

DETERMINANTS : Expansion of a determinant by different methods including pivotal condensation, Cauchy's and Laplaces' expansion.

REAL QUADRATIC FORMS: Positive, definite and other types of quadratic forms. Reduction of a quadratic form to a sum of squares.

ANALYSIS : Idea of uniform continuity. Stieltje's integral. Integrability of continuous functions. Use of Langrange's multipliers. Differentiation under the integral sign. Simple multiple integration. Integral along a given curve. Improper integrals.

(ii) Numerical analysis - one half paper

FINITE DIFFERENCES AND INTERPOLATION : Δ and E operators, divided difference. Newton's forward, backward and divided difference formulae (interpolation). Gauss' forward and backward formulae. Central difference formulae due to Bessel, Everett and Stirling. Derivation of the error term in the above interpolation formulae. Inverse differences and their use in summation. Subtabulation. Simple bivariate interpolation. Simple inverse interpolation. Numerical differentiation and integration. Simpson's one-third and three-eights rule, trapezoidal rule, Weddle's rule central difference quadrature formulae. Newton-Cote's formula, Gauss formula. Error terms in Trapezoidal. Simpson's and Weddle's rules Rulers Maclaurin's expansion, Striling's approximation to nI.

NUMERICAL SOLUTION OF ALGEBRAIC EQUATIONS IN ONE UNKNOWN : Newton-Raphson, Horner's and iteration methods; Graeffe's root squaring process for obtaining real roots. Extension of Newton- Raphson and iteration methods to the cases of more than two unknowns.

(iii) Probability - one half paper

Mathematical and statistical definitions of probability, Axiomatic, approach to probability for the discrete case only. Simple theorems on probability with examples. Conditional probability, independence of events in probability for two and three events. Bayes theorem. Discrete and continuous variates. Probability functions and probability density functions. Probability distributions in one or more variates, Mathematical expectation, Probability generating functions. Chebycheff's inequality. Weak law of large numbers. Simple form of central limit theorem. Moments and cumulants with their generating functions and relations. Factorial moments. Independence of variates. Idea of distribution of a transformation of a variate in univariate as well as bivariate case. Study of some standard distributions in a general way.

(iv) Statistical Methods—one half paper

Compilation, classification, tabulation and diagrammatic representation of various types of statistical data. Concepts of statistical population, random sample and frequency curve. Measures of location and dispersion. Concentration curve, moments and moment-generating functions, inequalities concerning moments, simple derivation of Sheppard's corrections, cumulants, measures of skewness and kurtosis. Study of standard distributions—binomial, Poisson, hypergeometric, normal, negative-binomial, rectangular and log normal distributions. Pearsonian system of curves-derivation of the differential equation and its solution yielding curves of Types I to VII, fitting of these curves by the method of moments, representation of these curves on the B_1—B_2 diagram.

Measures of association and contingency, Correlation and Linear regression involving two or more variables. Correlation ratio. Intraclass correlation, rank correlation. General properties of a bivariate distribution, bivariate normal distribution, multi-nomial and multivariate normal distribution (general properties). Concentration ellipsoid. Non-linear regression analysis and orthogonal polynomials.

Curve fitting by methods of free-hand curves, moving averages, group averages, least squares and moments.

(v) & (vi)   Sampling theory and tests of significance—two half papers

Statistics. concepts of sampling distribution and standard error. Standard error formulae for mean, multinomial proportions, moments and quantiles. Standard error of a function of statistics in large samples and its use in cases of standard deviation, coefficient of variation and correlation coefficient.

Use of transformations to stablise variance in large samples-logs, Z-transformation for correlation coefficients (total and partial), $\sin^{-1} \sqrt{p}$ and $\sqrt{x}$ transformations-derivations and uses.

Derivation of sampling distribution of mean of independent normal variates, χ^2, t and F statistics: their properties and uses. Derivation of sampling distributions of sample means, variances and correlation coefficient from a bivariate normal population, simple regression coefficient (non-stochastic predictor) and the exponent of a multivariate normal distribution.

Derivation (in large samples) and uses of Pearsonian χ^2

Tests for a single mean, difference of two means (uncorrelated and correlated cases), a single variance, ratio of two variances (uncorrelated and correlated cases), regression coefficient (simple and partial), correlation coefficients (simple, partial and multiple), combination of probabilities in tests of significance.

Heterogeneity and   analysis of variance and covariance. **Linear**

hypothesis and orthogonal splitting of the total variation. Selection of valid error. Analysis of variance and covariance in one way and two way classified layouts (analysis and variance with unequal numbers of observations in the cells excluded). Application of analysis of variance and covariance for testing regression coefficient, correlation ratio, linearity of regression, multiple correlation and partial regression coefficients, comparison of different regression coefficients.

(vii) & (viii) *Statistical inference—two half papers*

THEORY OF ESTIMATION : Requirements of a good estimate—unbiasedness, consistency, efficiency and sufficiency. Minimum variance properties and Rao-Cramer inequality. Correlation between an efficient estimator and an inefficient estimator.

METHODS OF ESTIMATION : General descriptions of the method of moments, method of maximum likelihood, method of least squares and method of minimum χ^2 Properties of maximum likelihood estimators (without proof).

THEORY OF CONFIDENCE INTERVALS : Simple problems of setting confidence limits.

THEORY OF TESTING OF HYPOTHESES : Simple and composite hypotheses. Tests and critical regions. Two kinds of error, level of significance and power of a test.

Optimum critical regions for simple hypotheses concerning one parameter. Construction of such regions for simple hypotheses relating to a Normal population.

Likelihood ratio tests and their properties (without proof).

Sequential tests of a simple hypothesis against a simple alternative (without derivation).

(ix) *Sampling techniques—one half paper*

Complete enumeration vs. sampling, requirements of a good sample. Simple random sampling. Random sampling numbers and their use. Systematic sampling. Stratified random sampling, proportional and optimum allocation, gain due to stratification determination of sample size. Descriptions of multi-stage, multi-phase and double sampling. Details of two stage sampling. Cluster sampling. Ratio and regression estimate. Sources of errors in surveys. General principles of sample surveys w.r.t. recent large-scale surveys in India.

(x) *Design of experiments—one half paper*

Principles of experimentation ; uniformity trials, completely randomised, randomised block and latin square designs, missing plot techniques.

Factorial experiments and their advantages. Confounding (total and partial) with reference to 2^5 and 3^3 factorial experiments. Split-plot design and strip arrangements.

(xi), (xii) & (xiii) Compulsory practical—three-half papers

The first half-paper to be based on sections (i), (ii) and (iv). The second half-paper to be based on sections (v) to (viii) and the last half paper to be based on sections (ix) & (x).

B.A./B.Sc. (Hons.) OPTIONAL GROUP

(i) Economic statistics—one-half paper

Concept, construction and use of price index numbers and tests in connection with them. Chain index number. Sensitive price index. Cost of living index number. Discussion on the construction of certain index numbers in India. Index number of production. Components of a time series; different methods for determining trend and seasonal indices; changing seasonal patterns; effect of trend elimination by the method of moving averages on other components of a time series. Stationary time series.

Analysis of family budget data—Engel curves, income elasticity of demand.

National income—methods for estimating national income—National Income of India.

(ii) Statistical quality control—one-half paper

Advantages of statistical quality control—control charts for attributes and variables (mean, range, s.d. fraction defective and number of defects) O.C. of control charts. Sampling problems in manufacturing industry; acceptance sampling plans by attributes, single, double, multiple and sequential. O.C., A.S.N. and A.O.Q. curves; ideas of inspection plans by variables.

(iii) Educational and psychological statistics—one-half paper

Percentile curves, percentile ranks and their uses. Combination and comparison of examination scores. Norms and scaling procedures. Intelligence quotient—intelligence tests and their standardisation. Individual and group tests. Determination of mean true score, relationship between true and error variances; properties of parallel tests; methods for the estimation of test reliabilty and validity.

(iv) Vital statistics—one-half paper

Vital statistics and their importance. Organizations for collection of vital statistics in India. Population census, Indian census. Errors in census and registration data and their adjustments.

Measurement of mortality—crude, specific and standardised death

rates, cause of death rate, infant mortality rate, maternal mortality rates, case fatality rate and death rate, Morbidity rates. Graduation of mortality rates by Gompertz and Makeham's laws. Description and construction of complete and abridged life tables. Measurement of fertility and reproduction, crude birth rate, total general and specific fertility rates, gross and net reproduction rates, vital index.

Comparisons of mortality, fertility and reproduction rates. Estimation of inter-censal population. Simple techniques for the study of population growth. Logistic curve and its fitting.

(v) *Optional practical—one-half paper*

Based on the two sections to be chosen from section (i) to (iv).

M.A./M.Sc. (Theoretical)

The committee feels that the following half-papers may be considered in the compulsory group and the universities may choose other six half-papers from the remaining portion of the list according to the resources available. The compulsory group may consist of the following half papers;

(*i*) General theory of measure and integration
(*ii*) Analysis
(*iii*) Matrices and quadratic forms
(*iv*) Numerical analysis
(*v*) Probability
(*vi*) Statistical methods
(*vii*) Sampling distribution
(*viii*) & (*ix*) Theory of inference
(*x*) Theory of sampling
(*xi*) Multivariate analysis
(*xii*) Design of experiments

Optional Group will consist of the following half-papers of which six half papers have to be selected:

(*i*) Theory of inference
(*ii*) & (*iii*) Theory of sampling and large scale sample survey
(*iv*) Design of Experiments
(*v*)(*vi*)&(*vii*) Mathematical economics, economic statistics and econometrics
(*viii*) & (*ix*) Stochastic processes
(*x*) Demography
(*xi*) & (*xii*) Industrial mangement and quality control
(*xiii*) Operations research
(*xiv*) Biometry and bio-assay

(*xv*) Genetical statistics

(*xvi*) Information and coding theory

(*xvii*) Psychometry

(*xviii*) Computing science

In the compulsory group there will be four half-papers in practicals and for optional group there will two half-papers. Practicals will include viva-voce and internal assessment. Allotment of marks in theoretical and practical papers have to be adjusted on the basis of the total marks in the subject. It is not possible to indicate the marks as it has been pointed out to the committee that the aggregate varies widely among the different universities.

There will be some common topics in M.Sc. and B.Sc. courses but these topics will be taught at a higher level in M.A./M.Sc. Detailed syllabi of the topics are given below :

M.A./M.Sc.(theoretical) Compulsory Group

(*i*) *General theory of measure and integration*

Algebra of sets, limit of a sequence of sets, ring fields, σ-ring, σ-field of sets, monotone classes. Minimal class, Borel field.

Set function, continuity of a set function, additive set function, measure, measure space. Measurable space, measurable sets, sample functions, elementary functions, measurable functions, measurability theorem.

Measure and convergence, sequence theorem, convergence in measure, convergence almost everywhere, uniform convergence.

The integral of a measurable function with respect to a given measure (constructive approach), elementary properties of integrals, Monotone convergence theorem, Fatou's lemma, Dominated convergence theorem.

Extension of measure, Lebesgue-Stieltjes measure, distribution function, correspondence between˝ Lebesgue-Stieltjes integral and distribution function, Radon-Nikodym theorem. Product measures and Fubini's theorem.

(*ii*) *Analysis*

Riemann integration and Mean value theorems. Riemann—Stieltjes integrals. Improper and infinite integrals. Uniform convergence of infinite series and integrals.

Beta and Gama integrals, double and repeated integrals, multiple integrals. Dirichlet's integrals. Elements of Fourier series, Laplace's transform and Mellin's inversion formula.

Complex numbers. Analytic functions. Cauchy's fundamental theorem.

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Cauchy's integral theorem. Taylor's and Laurent's series. Residues and Contour Integration.

(iii) *Matrices and quadratic forms*

Finite—dimensional vector spaces; Existence of a basis. Linear transformations. Matrices and determinants. Theorems on rank. Solution of a system of linear equations. Characteristic roots and vectors—spectral decomposition of a matrix.

Diagonalisation of a matrix. Triangular form and Jordan Canonical form of a matrix. Inverse of a matrix, generalized inverse of a matrix.

Inner-product space. Orthogonal transformation, orthogonal matrix, Gram-Schmidt orthogonalisation method. Reduction of quadratic forms.

(iv) *Numerical analysis*

Interpolation, numerical differentiation and integration formulae with remainder terms.

Solution of algebraic equations. The principle of integration. Graeffe's root-squaring process. Solution of difference equations, first and second order; solution of differential equations-Euler's method, Milne's method, Runge-Kutta method. Relaxation methods. Harmonic analysis.

(v) *Probability*

Probability space, events, random variable. Conditional probability and conditional expectations. Vector-valued random variable, its distribution function.

Convergence of a sequence of random variables, convergence in distribution, convergence in probability, almost sure convergence, convergence in quadratic mean, Helly-Bray Lemmas, Helly-Bray theorem.

Complex-valued random variables, characteristic function of a real and a vector-valued random variable, inversion theorem, continuity theorem, limit theorems

Independence, Weak laws of large numbers, Borel-Centelli Lemma, Boral zero—one law, Kolmogorov's inequality, Kolmogorov's strong law of large numbers. Central limit theorems.

(vi) *Statistical methods*

MOMENTS AND CUMULANTS : Problem of moments. Standard distributions; one-point and two-points-distributions, binomial, poisson and Polya distributions, multinomial distribution, uniform, Cauchy,

Laplace, Beta and Gamma distributions, normal and log-normal distribution. Compound binomial and compound Poisson distributions.

SYSTEMS OF FREQUENCY CURVES : Pearsonian curves, Gram-Charlier and Edgeworth expansions and improvements made by them on the central limit approximation to the distribution of a standardised sum, Bessel function (Im and Km) curves, Normalisation techniques. Bivariate distributions : General properties, ellipse of concentration, general theory of regression. Different measures of correlation, correlation ratio; contingency and association. uses of χ^2, multiple and partial correlation and regression.

CURVE FITTING : Method of least squares orthogonal polynomials and method of finite differences; standard errors and large sample tests.

(vii) Sampling distributions

The limiting form of the multinomial distribution, non-central Chi-square, t and F distributions.

Sampling distribution of linear functions of the observations from a normal population. Sampling distribution of the correlation coefficient r (non-null case), partial, multiple and rank correlations (both null and non-null cases).

Order statistics, transformation of variates, distribution of the smallest and greatest observations in random samples from a population, distribution of range and midrange, distribution of quantiles.

(viii) and (ix) Theory of Inference

Theory of point estimation—unbiasedness, consistency, efficiency and sufficiency of point estimators, maximum likelihood estimates and their properties, amount of information Cramer-Rao inequality and its generalization, Rao Blackwell theorem, completeness and bounded completeness, existence of minimum variance, unbiased estimates, confidence intervals.

Elements of decision theory—loss function, risk function, admissibility, Bayes and minimax decision rules, estimation and testing viewed as decision rules, randomized decision rules.

Theory of testing of hypotheses—simple and composite hypotheses, randomized tests and critical functions, Neyman Pearson Lemma, sufficient statistics and most powerful test, uniformly most powerful test for distribution with monotone likelihood ratio, unbiased tests, uniformly most powerful unbiased test for one parameter, exponential family, elements of composite hypothesis likelihood ratio tests, general linear hypothesis and its reduction to canonical form.

Non-parametric methods—estimation, tests and confidence intervals. Run tests, sign tests, wilcoxon and Mann-Whitney test, Median test,

Kolmogorov test, Kolmogorov-Smirnov test, Chi-square test. Tests for limiting distributions, large-sample properties of tests. Tests involving rank correlation and its permutation distribution.

(x) *Sampling*

Selection of sample units: with or without replacement, with equal and unequal probabilities. Two stage sampling, multistage sampling, stratified random sampling. Systematic sampling and cluster sampling. Use of auxiliary characters; ratio estimates, regression estimates. Double sampling.

Repetitive surveys—use of interpenetrating networks of sub-samples.

Practical considerations in conducting surveys and censuses—Planning and execution, schedules, analysis, preparation of reports.

Discussion of important sample surveys conducted in India. Assessment and control of non-sampling errors; sources of non-sampling errors, errors due to non-response.

(xi) *Multivariate analysis*

Bivariate and multivariate distributions; multivariate normal distribution; marginal and conditional distribution and their properties; wishart distribution and its reproductive property. Hotelling's T^2 and its optimum properties, Mahalanobis's D^2, wilks L_{mvc} tests of independence of sets of normal variates; classificatory problems and Fisher's discriminant function, canonical correlations, analysis of dispersion, principal components, elements of factor analysis.

(xii) *Design of experiments*

Linear estimation theory. Analysis of variance and covariance in fixed and random effect models. General theory of analysis of experimental designs, with one way and two way elimination of heterogeneity. Connectedness. Orthogonal and incomplete designs. Detailed study of some particular design as completely randomized, randomized block design, Latin square design, BIB design, youden's square and cross over design, missing plot technique; simple factorial design and partial confounding, split plot design.

M.A./M. Sc. (THEORETICAL) OPTIONAL GROUP

(i) *Theory of inference*

THEORY OF ESTIMATION : Bayes and minimax estimators, invariant estimators, estimators based on inverse sampling.

THEORY OF TESTING OF HYPOTHESES : Similar tests, tests of Neyman structure and uniformly most powerful similar tests, uniformly most powerful unbiased tests in the presence of nuisance parameters, Generalized Neyman-Pearson lemma and locally most powerful tests.

Invariant tests and uniformly most powerful invariant tests, bayes and minimax tests, large sample tests and confidence regions, consistency of test criteria.

Confidence regions, shortest confidence regions (in the Neyman sense) ; shortest unbiased confidence regions ; game theory and main theorems of decison theory.

(ii) Sampling

Estimation procedures. Estimation of population total or mean. Ratio and regression methods of estimation. Bias and sampling variance of estimators. Unbiased ratio estimators. Self weighting designs. Estimators of bias and sampling variance.

Combination of different sampling procedures into a composite sampling design. Comparison of advantages and disadvantages of different sampling designs.

Optimum designs. Cost and variance functions : components of cost and variance. Use of pilot surveys in estimating cost and variance functions. Optimum allocation of samples to strata, optimum size and structure of sampling units, optimum schemes of stratification, Optimum replacement fraction in repetitive surveys.

(iii) Large scale sample surveys

Planning, object of a statistical project; decision on the method of enquiry, nature of survey, setting-up of organizations for statistical and field work.

PREPARATORY : Building up of statistical and field organizations, choice and the construction of a sampling frame, pilot survey for the construction of cost and variance function and examination of a method of enquiry.

SAMPLE DESIGN : Optimum design for maximising precision; inter-penetrating, concurrent and supplementary samples to measure completeness of coverage, errors due to non-response, difference between investigators, difference in procedures of collection. Schedules and instructions : Field Scrutiny : Technical supervision of field work. Contact with field, visit by technical staff, keeping amendment to instructions etc. Recording; receipt of schedules, checking, stock taking, storing of records, despatch to other units for processing.

REPORT AND PUBLICATIONS : Checking of final tables. Interpretation of the tables. Report writing. Illustrations.

Jute Survey in Bengal and Bihar 1936; Crop surveys by States in India, National Sample Survey.

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(iv) Design of experiments

General analysis of incomplete block design with recovery of inter-block information.

Partially balanced incomplete block design, group divisible design, rectangular and square lattice design, multiple lattice design, general theory of factorial experiments, confounding partial confounding and fractional replicates. Analysis of groups of experiments.

Construction of (*i*) orthogonal latin squares; (*ii*) BIBD, PBIBD by 'method of finite geometries', method of finite differences and method of block section and intersection; (*iii*) Totally and partially confounded symmetric factorial designs; and (*iv*) Fractional replications.

(v) (vi) Mathematical economics; economic statistics; and

(vii) econometric methods

Assuming that a course on principles of economics can be drawn up (whenever it is needed) in consultation with economists, courses in mathematical economics, economic statistics and econometric methods are given below :

MATHEMATICAL ECONOMICS (HALF PAPER) : Price determination under monopoly and duopoly, input-output models, Leontief's inter-industry relations, theory of the firm, multiplier-accelerator, growth models of Harrod-Domar, Philips, Samuelson-Hicks and business cycles, stabilization policies, consumption and demand functions, production functions, stability of equilibrium and comparative statistics, distribution and concentration of income, activity analysis and linear programming.

ECONOMIC STATISTICS (HALF PAPER) : Sources of economic data and accuracy, evolution of Indian statistical system, functions and organization of CSO and of state statistical bureaux, maintenance of standards and co-ordination, comparative statistical system of UK, USA, USSR, and UNO.

Indian official publications on : (*i*) Agricultural statistics; (*ii*) industrial statistics; (*iii*) commercial statistics; (*iv*) labour statistics; (*v*) financial statistics; (*vi*) census and public health statistics; and (*vii*) transport, social accounts, annual estimates of Indian national income, financial flows.

Aggregation of economic variables, use and construction of index numbers—of prices, of cost of living, of trade.

Analysis of time series, trends, polynomial, logistic and log-normal, concepts of stationary time series, periodgram, correlograms of a moving average and of an auto-regressive time series.

1. Linear models :

    (a) Single-equation models.

    Review of assumptions of multiple regression in the context of economic applications.

    Problems of multicollinearity, errors in the variables and errors in the equations.

    Test of independence of disturbances by Durbin Watson statistics. Estimation of parameters when disturbances are autocorrelated.

    (b) Distributed lag-model and estimation of parameters.

    (c) Simultaneous equations model.

    Indefinability, Rank and order conditions, estimation by (*i*) indirect least squares (*ii*) limited information and (*iii*) full information.

    (d) Specific models relating to : (*i*) propensity to consume; and (*ii*) demand for food.

2. Short and long term planning models

3. Production functions (i) agriculture (ii) industry

4. Demand analysis

5. Forecasting in econometrics.

(viii) & (ix) *Stochastic processes*

A. DISCRETE STOCHASTIC PROCESSES: Convolutions, Compound distributions, recurrent events, delayed recurrent events, random walk models, absorbing, reflecting and elastic barriers, Gambler's ruin problems and limiting diffusion process, Markoff chains, transition probability, classification of states and chains, irreducible chains, spectral resolution of a matrix, evaluation of p (n). Discrete branching processes.

B. CONTINUOUS STOCHASTIC PROCESSES : Markov processes in continuous time, poisson process, Weiner processes, Kolmogorov-equations, random variable technique, homogeneous birth and death processes, divergent birth process, the effect of immigration, the general birth and death processes—multiplicative processes. Simple non-homogeneous processes—Polya processes. Multi-dimensional processes, queueing processes equilibrium theory, queues with many servers, first passage times, epidemic processes, chains-binomial models. Diffusion processes, application to population growth.

C. NON-MARKOVIAN PROCESSES: Supplementary variables, embedded

Markov processes, stationary processes, elements of prediction theory, spectral representation of point processes, the renewal processes.

(x) *Demography*

Census and vital statistics data, vital rates and ratios, standardisation of rates, trends and differentials in mortality and fertility, stationary population, construction of life tables, gross and net reproduction rate, stable population theory, population estimation and projection, demographic trends in India, labour force analysis, birth and death stochastic processes, stochastic population models, logistic model, bivariate growth models, migration models, fertility analysis models, mortality analysis models.

(xi) & (xii) *Industrial management and quality control*

1. QUALITY MANAGEMENT: Meaning of Total Quality Control, Organization for Quality Control, Quality costs.

2. PROCESS CONTROL : The general theory of control charts, control charts for variables, and attributes including coefficient of variation, extreme values and midranges moving average and moving range, fraction defective (when sample sizes vary), modified control chart, group control chart, cumulative sum techniques. Costs associated with control charts and their uses. The idea of joint control charts, applications of the theory of runs and related patterns.

3. PRODUCT CONTROL : General notion of acceptance sampling plans. Lot-by-lot sampling inspection by attributes.

Properties and determination of parameters of single, double and multiple sampling plans for LTPD, AOQL and AQL requirements. Continuous sampling plans by attributes. Shainin's, Dodge's and Wald-Wolfowitz plans. Sequential sampling plans for attributes. Sampling inspection by variables. Single and double sampling plans with known and unknown process standard deviation when the lot quality is described by the (a) process mean and (b) proportion defective (specifications being given).

4. RELIABILITY AND LIFE TESTING PROCEDURES : Concept of reliability. Early, chance and wear-out failures and corresponding failure density functions. Hazard function and Reliability function. Estimation of failure—density parameters. Point and interval estimation of reliability function.

(xiii) & (xiv) *Operations Research*

Definition and scope of operational research. Different types of models, their construction and general methods of solution. Simulation methods. Monte Carlo methods.

Elementary inventory models with restrictions. Replacement Models.

Storage systems, linear programming, simplex techniques, transport-

ation and assignment problems. Elements of non-linear and dynamic programming, integer programming.

Queueing theory, sequencing theory.

Elements of the theory of games.

Work study, time and motion study.

(xv) Biometry and bio-assays

BIOMETRY : Multiple measurements-variation and correlation in multiple measurements. Methods of analysis of anthropometric and taxonomic measurements.

BIO-ASSAYS : Direct assays, quantitative dose-response relationships, linearizing transformation, non-linear regressions, parallel-line assay—choice of dose and efficiency in indirect assays—designs suitable for bio-assays. Indirect assays based on quantal response—probit, logit and angular transformations, the median effective dose and its variance. Alternative methods for analysis of quantal responses.

(xvi) Genetical statistics

ELEMENTS OF GENETICS : Physical basis of heredity-cell structure, reproduction-Mendel's laws of inheritance-interaction between genes. Linkage-multiple alleles.

Gene frequency. Hardy-Weinberg law in random mating.

Extension to multiple allelic systems.

Autopolyploids and self sterlity alleles.

Disequilibrium due to linkage in autosomal and sex-linked genes.

ANALYSIS OF SEGREGATION : Detection and estimation of linkage in qualitative systems. Disturbed segregation.

Elementary discussion of special features of study of inheritance in man with illustrations from blood group, disease traits, etc.

Elementary stochastic theory of genetic populations.

Co-efficients of relationships and inbreeding, method of path co-efficients. Homozygosity under regular systems of inbreeding. The Generation Matrix theory of inbreeding.

Inheritance of quantitative characters—Metrical bias—tests of scaling—components of variation. Selection for quantitative character.

(xvii) Information and coding theory

ENTROPY CONCEPTS IN INFORMATION THEORY : Entropy of finite schemes and Markov chain, fundamental theorems of information theory. Continuous channels without memory. Transmission of band limited signals. Communication under stochastic regimes.

THEORY OF CODES : Linear codes, capabilities of linear codes. Important linear codes, Cyclic codes and Bose-Ray-Chaudhury codes.

(xviii) Psychometry

Problem of tests, measures of reliability and validity, methods of scoring tests, problems of weighting and differential prediction, item analysis. Scaling methods—paired comparisons, rank order comparisons, scaling from internal and ratio judgement rating scales, constant errors and their control, Thurstone, Likert and Guttman method of scale analysis. Factor analysis, general formulation of the model, principal component method, centroid method, oblique multiple factor solutions ; estimation of factors, statistical tests of hypotheses in factor analysis, Stochastic model for learning process.

(xix) & (xx) Computer Science

PROGRAMMING LANGUAGE : FORTRAN, ALGOL, COBOL programming: Punched cards and other recording media, unit record systems. Functional units of a computer, flow of information in the system, memory flow charts and programming, character representation, binary number system, tests and decisions, loops in programmes, index registers and sub-routines. Machine language and symbolic language, programming and operating the computer.

THEORY OF GRAPHS : Planar graphs, Turan's theorem, Ramsey's theorem, logical designs, memory elements, sequential circuits, minimum state machines, simple properties of threshold functions, chebyshev approximation, computer arithmetic.

Computation techniques, solution of linear equations, inversion of matrices, eigen values and eigen vectors of matrices, error analysis, simplex method and variants, gradient method, predictor-corrector methods for solving ordinary differential equations, explicit and implicit methods of solving boundary value problems, minimisation principles for obtaining approximate solution of boundary value problems.

(xxi) & (xxii) Practical, optional (two half papers) based on the sections to be chosen from the optional groups (i) to (xx).

M.A./M.Sc. Practicals

BASIC PRACTICALS—4 HALF PAPERS

Practical I   —Numerical analysis and data processing.
Practical II   —Statistical methods and sampling distributions.

Practical III — Statistical inference and multivariate analysis.

Practical IV — Sampling & design of experiments.

Practical I

1. Graduation by a summation formula.

2. Pivotal value and interpolation by an osculatory formula.

3. Blending two series by (i) curve of sines (ii) curve of squares and (iii) polynomial blending functions.

4. Numerical integration by the formula of Gauss and assessment of error.

5. Solution of an equation by the principle iteration.

6. Complete solution of the roots of a polynomial by Graeffe's root-squaring process.

7. Solution of a system of non-homogeneous equations by the method of Sweep-out.

8. Inversion of a non-singular matrix.

9. Obtain a g-inverse of a rectangular matrix.

10. Solution of difference equations of the 1st & 2nd orders.

11. Solution of differential equations by Euler's Method.

12. Solution of differential equations by Milne's Method.

13. Solution of differential equations by Runge-Kutta Method.

14. Use of relaxation method in solution of (i) linear algebraic equations, (ii) difference equations, (iii) differential equations.

5. & 16. Coding, punching, verification, sorting and tabulation of data.

17. Writing of computer programme for solution of simultaneous equations.

18. Writing of computer programme for inversion of matrices.

19. Writing of computer programme for one-way and two-way classification in Analysis of variance.

20. Writing of computer programme for linear correlation coefficient.

21. Writing of computer programme for multiple and partial correlation.

22. Writing of computer programme for quadrature by Simpson's rule.

23. Writing a computer programme for the evaluation of a determinant.

24. Writing a computer programme for polynomial curve fitting.

Practical II

1. Fitting of negative binomial distribution to sets of observed data.

2. Fitting of hypergeometric distribution to sets of observed data.

3. Fitting of multinomial distribution to sets of observed data.

4. Fitting a mixture of two normal curves to observed bimodal data.

5. Fitting a lognormal distribution to observed data.

6. Fitting Gram-Charlier Series to observed data.

7. Fitting Edgeworth Series to observed data.

8. Fitting Pearson Type I curve.

9. Fitting Pearson Type III curve.

10. Drawing of 100 samples of size 5 from a specified normal population.

11. χ^2-distribution application of '

12. t-distribution application of

13. F-distribution application of

14. Fitting of curves by orthogonal polynomials.

15. Large sample tests.

16. Calculation of correlation ratio, biseral r and rank correlation.

17. A problem involving m-ranking.

18. Calculation of partial correlation coefficient and testing it for significance.

19. Calculation of multiple correlation and testing it for significance.

20. Addition and deletion of independent variates in multiple regression problem.

21. Drawing of 100 random samples of size 4 from R(0, 1).

22. Uses of non-central t-distribution and non-central F-distribution.

Practical III

1. Estimation of the fish population of a lake by the method of maximum likelihood.

2. Estimation of Probit by the method of maximum likelihood.

3. Maximum likelihood estimate of a genetical parameter and information by the scoring method.

4. Shortest Average Confidence Interval.

5. Confidence limits for the parameter in the binomial and Poisson distributions based on Chi-square and F-distributions.

6. Construction of MP test for $\theta=1$ against $\theta=2$ given a random sample of size 10 from $f(x,\theta)=\theta e^{-\theta x}$, $x \geqslant \theta$. Drawing of the corresponding power curve.

7. Type A Test construction and drawing of power curve for $\sigma=1$ given a random sample of size 10 from $N(0,\sigma)$.

8. Power curve of the F test, for testing $\sigma_1^2=\sigma_2^2$.

9. Use of power curve for determining sample size in planning of experiments.

10. Given k samples from k normal populations, testing by likelihood ratio test, the equality of variances of the k populations.

11. Sequential test for the binomial parameter $p=p_0$ against $p=p_1>p_0$ ASN and OC curves.

12. Sequential test for (i) $\mu=\mu_0$ against $\mu=\mu_1>\mu_0$ in $N(\mu,1)$ the ASN and OC (ii) $\sigma=\sigma_0$ against $\sigma=\sigma_1>\sigma_0$ in $N(0,\sigma)$ the ASN and OC.

13. Power of the sign Test for the median of a population $\mu=\mu_0$ against the alternative $\mu>\mu_0$ given n independent observations from the population. Comparison of the power against a Normal alternative.

14. Kolmogorov test for testing whether a given sample has come from a specified population.

15. Kolmogorov-Smirnov test for testing the hypothesis that two samples have come from populations with the same continuous distribution function.

16. Calculation of (i) Wald-Wolfouitz (ii) Wilcoxon (iii) Mann and Whitney criteria for two samples having been drawn from populations with the same continuous distribution.

17. Determination of the decision function that provides minima solution for the decision problem where the random variate has a two-point distribution, the parameter space and decision space each containing two elements and a suitable loss function is given.

18. Testing by Hotelling's T^2 whether the sample is from a multi-normal population with mean vector given in (19).

19. Exercises using classical and studentised D^2.

20. Finding the best linear discriminant function to test the

hypothesis that two multinormal populations with identical dispersion matrix have the same mean vector.

21. Testing whether a given observation belongs to one of two given multinormal populations with the help of the discriminant function.

22. Tests with Wilk's $\wedge$ criterion for independence of sets of normal variates.

23. Test of differences of mean values of several populations.

24. Canonical Correlation.

Practical IV

1. Stratified random sampling without replacement with (i) arbitrary (ii) proportional (iii) optimum allocation with and without simple cost functions. Gain due to stratification.

2. & 3. Ratio method; regression method.

4. to 6. Cluster Sampling. (i) Equal probability, equal clusters, mean of means (ii) equal probability, unequal clusters, weighted mean of means (iii) equal probability, unequal clusters, unweighted mean of means (iv) equal probability, unequal clusters, mean per secondary unit (v) equal probability, unequal clusters, mean per unit area (vi) cluster selection with probability proportional to (a) a number of elementary units in the cluster (b) area of cluster.

7. Two-stage sampling. (i) equal probability selection at both stages and sampling without replacement.

8. Stratified multistage sampling.

9. Optimum allocation in double sampling.

10. Optimum plan for non-response resurvey.

11. Systematic sampling—linear systematic sample, circular systematic sample.

12. Graeco-Latin and higher order design.

13. Cross-over design.

14. Balanced incomplete block design.

15. Designs for two-way elimination of heterogeneity. Youden square.

16. Analysis of standard designs with yields missing or mixed-up.

17. & 18. -3^3 complete factorial experiments 2 x 3 x 2 experiment.

19. & 20. Split plot designs in (i) randomised blocks, (ii) latin squares,

(iii) strip-plot.

21. to 23. Confounding in 3^3 factorial experiment (ii) simple asymmetrical factorial experiment (iii) split-plot confounding.

24. Covariance in a randomised block design.

M. A. (Economics)—statistics special group

Looking to trend of thinking and research in economics, a competent economist today must have sufficient facility in handling statistical methods. What the world 'sufficient' means would be indicated in the syllabi attached to this note. It may be noted that all the syllabi mentioned in this section refers to postgraduate training in economics. What we would like to discuss here is that the knowledge of statistical techniques is valuable to an economist for several inter-related but conceptually distinct reasons. First, and in a way the most compelling reason, is the need for summarizing a large mass of data which emerge from different sources, official and non-official. A second reason is the need to collect 'information' in the light of a certain hypothesis. In other words, just as in experimental/natural sciences, one has to devise experiments, in subjects such as economics, it is important to collect information which may not otherwise be available in the form that we would find meaningful. Thirdly, statistical techniques are useful to discriminate between alternative hypotheses, each of which has a certain amount of a prior plausibility. Finally, there is the need to take decisions in the light of uncertainty, which requires knowledge of probability calculus, which forms the conceptual basis of statistical procedures.

In recent literature dealing with the application of statistical techniques to economics, each of these uses has found an important role. A competent social scientist today working in an area such as economics must be familiar with all these uses, to certain degree at least.

It would, however, appear, from an examination of the syllabi which are presented to students of economics of different Indian universities that most of them do not pay sufficient attention to the third and fourth uses. Even the second use is insufficiently emphasized. It may be said that only the first and rather obvious use is emphasized to the exclusion of other uses. One of the main reasons for this acute deficiency is the lack of any significant mathematical training on the part of an average economist. While it has been recognized in general that mathematics forms a very convenient language in dealing with most quantitative work, not to speak of its general role in explicit deductive systems, Indian universities do not pay sufficient attention to the mathematical training of social scientists, in particular, to that of economics.

Some improvement in the knowledge of mathematics is absolutely essential to upgrade the quality of courses taught in the statistics. A course in elementary mathematics prepared and implemented at the Delhi School of Economics which if generally adopted would lead to a much better training in basic statistics, understood in the totality of its all relevant uses.

The syllabi given here makes a distinction between two types of courses in statistics. One of these courses is a basic course, called a course in quantitative methods of economics, which presupposes only knowledge of elementary mathematics as mentioned earlier. The other course is a much more specialized one which may be expected to train econometricians. Here also we make a distinction between two types of courses: one emphasizing techniques and their applications and the other dealing with proofs. The latter course would require a much greater degree of mathematical sophistication for which a separate mathematics programme is also attached.

If it is the case that even a knowledge of what is called here elementary mathematics is too much to expect, then the basic course in statistics should be redesigned and a separate course outline may be used, which is also indicated in the Appendix.

In all, there are three basic types of courses. First, a course in 'quantitative methods' requiring a knowledge of 'elementary mathematics' as suggested earlier. Second, an advanced course meant for econometricians. Thirdly, a course in Statistics for which background knowledge of high school algebra, is the maximum that can be assumed by way of mathematical training.

It is a relatively minor issue whether these courses would be taught by the economics department or the statistics/mathematics department of a particular university. In the latter case collaboration between the different departments would be needed for most effective implementation. There may, however, be situations where all of these courses may be taught by the economics departments concered. That would, however, appear to be a rather special situation in the present Indian context.

Syllabi for the following courses are given below :

  (i) A course on elementary mathematics

 (ii) A course on quantitative methods in economics

(iii) A course on 'advanced mathematics' for econometricians

(iv) A course on elementary econometric methods

 (v) A course on theoretical statistics

(vi) A course on advanced econometrics

(i) *Elementary mathematics (two half papers)*

Functions of one and two variables and their geometric representation, limit and continuity of functions.

Analytical geometry of two dimensions

Differentiation and integration of function of one variable

Differential calculus of several variables

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Problems of maxima and minima

Matrix operations, determinants

Solution of equations

(ii) Quantitative methods in economics (two half papers)

1. Use of mathematics and statistics in economics, characteristics distinguishing measurement in economics from measurement in the natural sciences; role of aggregations and index numbers in economic statistics. Accuracy of economic observations and errors in economic relations.

2. Descriptive statistics including curve fitting : empirical frequency distribution, mean, standard deviation, moments, correlation, least squares method of curve fitting including fitting of trends to time series data.

3. The probability basis of statistics:

(a) Sample space, events, probability measures, fundamental laws of probability;

(b) Random variables, probability distributions, mathematical expectations, moments, binomial distribution; the univariate and bivariate normal distributions.

(c) Bernonlli's theorem (law of large numbers), central limit theorem illustrated by simple examples (e.g., De-Moivre-Laplace theorem).

4. Statistical inference:

(a) Random sampling, sample estimates of population parameters;

(b) Point and interval estimation; unbiasedness, consistency, and efficiency; the method of maximum likelihood, confidence interval.

(c) Tests of hypotheses : null hypotheses, alternative hypothesis first and second kinds of errors; power of a test. Examples of tests involving the use of z, t and F statistics.

5. Statistical inference in multiple regression analysis (The material of this section is to be illustrated by examples from section 7 below).

6. Some applications of regression analysis :

(a) Estimation of demand functions using family budget and time series data.

(b) Estimation of production functions ; the Cobb-Douglas production function.

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      (c)   Estimation of macro-economic models; Klein's Model I.

7.   Elements of linear programming and input-output analysis

8.   Uncertainty theory :
      (i)   Uncertainty and probability
      (ii) The concept of a strategy
      (iii) Curve theory
      (iv) Production and inventory decisions
      (v)   Stochastic Programming

(I) *List of Practical Exercises*

1.   Computation of the mean, S.D. and central moments of order 3 and 4—ungrouped and grouped data.

2.   Fitting of a normal distribution to a set of grouped data in Exercise 1.

3.   Calculation of regression and correlation coefficients
      (i)   Bivariate data
      (ii) Trivariate data

4.   Curve fitting
      (i)   Polynomial trends
      (ii) The Pareto distribution

(ii) *Estimation and testing of hypotheses*

    (Many of the exercises will utilize the statistics computed in section I and will not require much time)

5.   Small and large sample tests of and confidence intervals for means.

6.   Tests of and confidence intervals for variances.

7.   Tests of and confidence intervals for regression coefficients.

8.   Durbin-Watson statistic and the test of serial correlation.

9.   Estimation and testing of parameters of demand functions.

10.   Estimation and testing of parameters of production functions.

11.   Prediction.

(iii) *Linear-programming and input-output analysis*

12.   The simplex method.

13. Inversion of the Leontrif matrix.

(iii) Syllabus for Advanced Mathematics (two half papers)

A. ANALYSIS INVOLVING ONE REAL VARIABLE

(1) The construction of the real number system.

(2) Topology of the real line.

(3) Properties of continuous and differentiable functions.

(4) Infinite series, including questions of uniform convergence.

(5) The Riemann-Stieltjes integral.

B. LINEAR ALGEBRA

(1) Basic concepts of a finite dimensional vector space, theorem on basis, etc.

(2) Linear transformations, their matrix representation.

(3) Solution of a system of linear equations, existence theorems, non-negativety theorems.

(4) Quadratic forms.

(5) Non-negative square matrices.

C. ANALYSIS INVOLVING SEVERAL VARIABLES

(1) Theory of maxima and minima.

(2) Conditional Extrema.

(3) Non-linear programming.

(iv) Elementary Econometric methods (two half papers)

1. A brief review of multiple regression analysis.

Specifying assumptions and their econometric implications. Best linear unbiased estimates and their sampling variances ; Tests of significance and confidence interval ; prediction.

2. Auto-correlation and other problems in the single-equation context ; The consequences of auto-correlated disturbances ; the Durbin-Watson statistics ; estimation methods.

Heteroscedasticity and generalised least squares. Lagged variables and estimation of distributed lag models.

Errors in variables and consequences ; instrumental variables.

3. Simultaneous—equation Models.

General model ; specifying assumptions and interpretation ; identification problems. rank and other conditions of identifiability ; estimation methods ; two-stage least squares and limited-information maximum likelihood methods.

(v) Theoretical statistics (three half papers)

1. Probability and probability distributions, theorems of total and compound probability, Baye's theorem, random variables and probability distributions, conditional and marginal distributions, independent random variables, function of random variables ; characteristics of distributions ; Moment-generating and characteristic functions ; inversion theorem ; Chebyshew's inequality, law of large numbers. The central limit theorem.

2. Some important probability distributions.

    (a) Discrete type ; Binomial, Poisson, hyper-geometric and multinomial distributions.

    (b) Continuous type : rectangular, normal, gama and beta distributions.

3. Sampling distributions

Non-central chi-square and non-central F; the distribution of quadratic forms, indepzndence of quadratic forms, independance of linear and quadratic forms.

4. Point and interval estimation.

Properties of unbiasedness, consistency, sufficiency and efficiency of estimates; Cramer-Rao inequality and the Rao-Blackwell Theorem. The method of maximum likelihood and its properties. The theory of confidenc2 regions.

5. Testing of hypotheses.

Simple and composite hypotheses, Neyman, Pearson lemma, power curves, likelihood ratio test.

6. The theory of linear estimation and test of hypotheses.

Observational equations, best linear unbiased estimates; principle of substitution ; standard errors of estimates; Test of the general linear hypothesis.

Analysis of variance and covariance—one-way and two-way classifications (additive models).

7. Multivariate analysis

Multivariate distributions, regression and correlation in several variables, linear regression, partial correlation, the multiple correlation coefficient, correlation ratio.

The multivariate normal distribution, marginal and conditional distributions, regression and correlation.

Sampling from the multivariate normal distributions; Hotelling's T^2 and Mahalanobis D^2 statistics (only uses). The distributions of the partial and multiple correlation coefficients (no derivations).

Theory of Principal components, canonical correlations and discriminant analysis.

(*vi*) *Econometrics* (*three half papers*)

1. Multiple regression analysis—single equation; least squares and maximum likelihood methods of estimation; test of the general linear hypothesis.

2. Testing the independence of regression disturbances—Durbin-Watson and Theil-Nagar tests, treatment of the first-order Markov Scheme, heteroscedasticity, Aitken's generalized squares method.

3. Problems of lagged variables, distributed lag models; method of estimation.

4. Errors in variables models, the classical approach, grouping methods due to Wald, Bartlett and Theil, and the method of instrumental variables.

5. Interdependent regression equations, Zellner's seemingly unrelated regression equation (S U R E) estimators.

6. Simultaneous equation models. General model, specifying assumptions and interpretation; identification problem; the rank and order conditions of identifiability; methods of estimation : (a) limited information methods (general K-class estimators, two-stage least squares and maximum-likelihood), (b) full-information methods (three-stage least-squares and maximum likelihood); their asymptotic properties; tests of identifying restrictions; identifiability test statistics and its asymptolic distribution.

7. Forecasting in econometrics: problems and methods of forecasting and accuracy analysis.

8. Linear aggregation of economic relations : the aggregation over individuals and commodities.

9. Time series analysis : fitting of trend; variate difference method, auto-regressive schemes (only up to second order) and correlogram analysis, spectral analysis.

B. Com. (Statistics)

It is suggested that B. Com. (Statistics) may consist of two groups (i) compulsory (ii) optional. The optional group should be taken by students

with adequate knowledge of mathematics. Details of the syllabi are given below :

(*i*) & (*ii*) *Compulsory group* (*two half papers*)

    (a)   Collection of data (primary and secondary)

           Objectives, concepts and definitions

           Errors (random and non-random)

           Official Statistics

           Statistical Methods

Graphical and pictorial representation of data, frequency distributions and frequency diagram, elementary methods of interpolation and grduation. Measures of central tendency, dispersion, simple correlation and regression.

    (b)   Elementary analysis of time series

Index numbers of prices, cost of living, production etc., national income and national budgets.

(*iii*) & (*iv*) *Optional group* (*two half papers*)

    (a) Elementary theory of probability and simple distributions e.g. binomial, normal and poisson. Elements of sampling, uses of t, X^2 F, tests partial and multiple correlation and multiple regression. Elementary theory of estimation and testing of hypothesis.

    (b) Econometric methods, demand functions, production functions, income distribution, measures of inequality of distribution, industrial statistics ; SQC methods, x, R chart, P chart, C chart, work study, production planning.

M. Com. (Statistics)

Students who had taken optional group or equivalent course in B. Com. degrees should be eligible for this course.

Group I (*two half papers*)

    (a) Advanced statistical methods applicable to multivariate analysis for items (a) in the optional group of B. Com. degree course.

    (b) Advanced methods for items (b) in compulsory group of B. Com. degree course.

Group II (*two half papers*)

    (a) Advanced methods for items (b) in the optional group of the

B. Com. degree course.

    (b) Marketing research and business forecasting.

(c) Operational research, definition and basic concepts, applications in inventory control, allocation, waiting list, budgeting etc.

(d) Linear programming, simplex methods, stochastic programming, application to transport problems, industrial problems.

(e) Elements of game, theory and decision theory.

Certificate Course in Statistics

The course is intended for students and research workers in disciplines of science other than statistics. The duration of the course will be six months to one year according to the facilities available in the departments of statistics in different universities. The course shall consist of the following papers : (i) mathematics and probability; (ii) statistical methods; (iii) sampling techniques and design of experiments ; and (iv) practical.

The number of hours required for each paper will be approximately 60. In addition to the above basic courses, any university may organize additional courses in one or more of the following specialized topics :

   (i) Statistical quality control
  (ii) Operational research
 (iii) Economic statistics
  (iv) Demography
   (v) Psychometry
  (vi) Manpower statistics
 (vii) Data processing and computer technology

The duration, number of lectures and detailed syllabi of the above courses may be drawn up as required.

The detailed syllabi of the papers are given below :

(i) Mathematics and probability (two half papers)

Matrix-addition and multiplication. Transpose and adjoint of a matrix. Inverse of a matrix. Rank of a matrix. Solutions of homogenous and non-homogeneous linear equations.

Determinants-properties and expansion of a determinant. Solution of equations by the use of determinants.

Numerical analysis-interpolation formulae and their uses. Simple formulae for numerical differentiation and integration. Numerical solution of algebraic equations.

Probability—simple theorems on probability with examples. Conditional probabilty. Stochastic independence. Repeated trials. Random variables. Expectation. Chebyshev's inequality. Law of large numbers.

(ii) Statistical Methods (two half papers)

Classification, tabulation and compilation and diagrammatic represen-

tation of statistical data. Concept of statistical population. Random sampling, frequency curves. Measures of location and dispersion. Moments and cumulants. Binomial, Poisson and normal distributions. Measures of association and contingency. Correlation and linear regression. Correlation ratio. Rank correlation. Method of least squares for curve fitting. Partial and multiple correlation for three variates. Concepts of sampling distribution and standard error. Large sample tests. Sampling distribution of t, F, and Chi-square (derivation is not required)—their properties and uses. Analysis of variance and covariance in one-way and two-way classified lay-outs. Applications of analysis of variance for testing regression coefficients, multiple and partial correlation coefficients.

(iii) *Sampling techniques and design of experiments (two half papers)*

Sampling technique—complete enumeration *vs.* sampling. Simple random sampling. Random sampling numbers and their uses. Stratified random sampling—proportional and optimum allocation. Gain due to stratification. Description of systematic sampling, multistage, multiphase and double sampling. Concept of errors in sample surveys.

Design of experiments. Properties of experimentation. Randomised block and Latin-square designs. Factorial experiments and their advantages. Confounding (total and partial) with reference to $2^n=2$ (i) 5. (3^2 and 3^3) in blocks of 3 and 9 respectively. Split plot designs groups of experiments.

(iv) *Practical (two half papers)*

Practicals to be based on papers (ii) and (iii).

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RESEARCH IN UNIVERSITIES

Although Statistics has been introduced rather recently in the curricula of Indian Universities and in some of them Statistics Departments are not even a decade old, researches in both theoretical and applied statistics carried out in Indian Universities have made significant contributions to the advancement of this science. Researches in the different universities cover a variety of aspects including measure theory and probability, sampling techniques, design of experiments, multivariate analysis, statistical inference and stochastic processes as also economic statistics, statistical quality control, demography genetics and operations research. Papers by research workers and teachers of university statistics departments have been published in various journals of India and abroad. The following gives a brief outline of the nature of problems dealt with by researchers in different universities arranged alphabetically. This is based on the material supplied by the universities.

Agra University

Problems of sampling and of statistical inference have been dealt with by workers in the Institute of Social Sciences, Agra.

Aligarh Muslim University

Papers published by the teaching and research staff of Aligarh Muslim University relate to probability and measure theory, sampling techniques and descriptive statistics.

Andhra University

The lines of research at present in the Andhra University Department of Statistics cover a wide range of topics like operations research, probability, inference, sample surveys and different aspects of stochastic processes.

Annamalai University

Research work carried out by scholars and teachers in the Annamalai University since 1960 relate to probability theory, sample surveys, order statistics, designs, attribute and variable sampling plans. Starting with Kolmogorov's axioms a study has been made on the characterisation of Lusin spaces, the Domain of attraction of Normal law and certain allied topics on combinatorial analysis. Distributions of order statistics and the

difference of two order statistics from any population and particularly from an exponential and rectangular populations have been investigated. Modifications for discrete distributions have also been studied. The structure and nature of the characteristic equation of the incidence matrix of B.I.B. designs have been also studied. Some aspects of acceptance sampling plans have also been investigated.

Banaras Hindu University

Research workers in the department of Statistics, Banaras Hindu University, work mainly in the fields of applied probability, demography, estimation and design of experiments.

Baroda University

Research students in the M.S. University of Baroda are working on problems in design of experiments, transformation of variates educational statistics, quality control and demography.

Bombay University

The University of Bombay has made significant contributions to the field of design of experiments. Work has also been done in multivariate analysis, estimation and decision problems, econometrics and operations research.

Calcutta University

Work in diverse fields has been done in the Calcutta University. Major contributions have been made in the fields of sampling techniques, non-parametric methods, multivariate analysis, genetic structures of populations, sequential probability ratio tests, quality control, psychometry, demography, testing of hypotheses and many other problems.

Delhi University

In the University of Delhi, various aspects of mathematical statistics (including probability theory and its applications) have been investigated. These include (i) stochastic processes, specifically in the statistical theory of random walk and renewal problems, (ii) statistical inference, specially non-Bayesian inference and estimation, (iii) probability distributions, (iv) multivariate analysis, (v) queuing theory, reliability and maintenance, (vi) information theory, and (vii) design of experiments.

Dibrugarh University

In the recently established statistics department at Dibrugarh some work is being done on mathematical programming including integer programming, information theory and tests of significance based on information. Work on storage strategies and queuing systems is contemplated.

Gauhati University

At Gauhati, researches relate to sampling distribution connected with mean square successive difference and bio-statistical models for inter-birth intervals.

Gujarat University

In the Gujarat University, Ahmedabad, the main topics on which research work is being done are multivariate analysis, characterisation or probability distributions (extension of the work by Rao and Lukacs) distribution of order statistics, statistical inference, censored and truncated distributions.

Karnatak University

At Karnatak, work has been done on stochastic processes, sampling theory and inference. In stochastic processes they work on model building and the associated inference problems. Asymptotic inference (parametric case), Bayesian techniques in comparing populations, successive sampling and sampling with varying probabilities are also being studied.

Kerala University

Diverse work is being done in the Kerala Univeristy, Department of Statistics. Papers published by the staff and research workers relate to probability models, stochastic processes, multivariate analysis, statistical inference, design of experiments, demography and operations research.

Lucknow University

Work is being done on (i) theory of statistical inference; and (ii) design of experiments.

Madras University

Work done by the members of staff/research scholars of the Madras University covers a wide variety of fields both pure and applied. On the methodological side the work being done covers 'Sampling distributions', 'testing of statistical hypotheses' and 'Stochastic processes'. On the applied side, topics are selected from aspects of trade, industry and prices, and a number of papers have been published incorporating analysis of data and interpretation of results.

Mysore University

Researches in the University of Mysore centre round limit theorems for functionals of partial sums of independent and certain types of dependent random variables. Problems in the field of random variables taking value in abstract spaces like topological groups etc., are also being studied.

Nagpur University

Research work being done in the college of Science, Nagpur bears on the unified theory of sampling from finite populations.

Osmania University

At Osmania, problems in probability theory and stochastic processes were being studied prior to 1965. Later, with the formation of a separate department in Statistics, researches in non-parametric inference, specially non-parametric estimation, have been undertaken.

Patna University

Research work in the university department of Statistics, Patna University relates mainly to (i) mathematical statistics (ii) design of experiments (iii) econometrics and (iv) demography.

Panjab University

In the Panjab University at Chandigarh, research students have been working on probability theory, statistical inference and trunaeted distributions. The staff is engaged in research on the following topics:

1. Non-paramatric inference with special reference to multi-sample multivariate problems.

2. Multivariate analysis with special reference to the distributions of some statistics.

3. Combinatorial methods, coding theory and graph theory with special reference to design of experiments.

4. Statistical inference based on incompletely specified univariate models.

5. Problems of constructing strata in sample surveys.

Poona University

In the Poona University, researches have been done in the fields of analysis, probability theory, invariance theory statistical inference, non-parametric methods and multivariate analysis, distance functions, sequential analysis, stochastic processes, theory of queues, probability distributions and econometric problems.

Rajasthan University

Sampling techniques have engaged researchers in the University of Rajasthan. Some applied work on wastage in Education, estimation of demands of cereals, public opinion on planning, has also been done.

Sardar Patel University

In the Sardar Patel University work is being done in two major

areas viz., design of experiments and estimation of parameters in probability distributions.

Utkal University

Members of the staff in the Utkal University are doing research on estimation and testing of hypothesis, probability and probability distributions, non-parametric methods and combinatorial analysis. Some applied researches in the field of education are also progressing.

Sri Venkateswara University

In the Venkateswara University research is going on mainly in two directions viz., estimation from defective data and stochastic models. Since statistical data in our country are likely to be defective, conventional methods of estimation cannot be applied and hence the necessity of new methods.

Vikram University

Research activities in the Vikram University include work on (i) statistical inference ; and (ii) testing and estimation problems.

VIEWPOINTS OF 'ARBEITSGEBER'

One of the terms of reference of the Statistics Review Committee was to suggest such steps as might be necessary for effecting a close collaboration between the university departments of statistics and the industrial units/government departments where statistical techniques are being applied to different practical situations. In order to obtain a first hand information about the extent and the type of collaboration which exists between the university departments and industrial undertakings/government departments etc., and also to assess the requirements as envisaged by potential employers, the members of the committee went round certain selected industrial units/government departments/universities/research organizations ; a list of these institutions is given at the end of this chapter.

In the different industrial units/government departments which the members visited, discussions were held with the heads of organizations as well as personnel concerned with the application of statistical techniques to various types of practical situations. The discussions were extremely fruitful and a number of useful suggestions were made by the heads of organizations whom the members met. A gist of the salient features of the main suggestions made is given below under the following three heads : (i) industrial undertakings/units ; (ii) government departments ; and (iii) training and research institutions.

(i) Industrial undertakings/units

The most important issue which was stressed by almost all the industrial undertakings which the members visited was the fact that the present day training given to our students at the M.A./M.Sc. level was not sufficiently oriented for practical work. Fresh products from the universities are good so far as the theoretical aspects of the subject are concerned but are not able to cope straight away with practical situations.

It has become necessary for the statisticians entering industrial undertakings to receive a preliminary 'on the job' training for about six months to one year usually for getting into grips with the problems which they have to tackle in the particular field concerned.

After this initial training it was observed that many of the statisticians were able to acquire the necessary skill in applying specific statistical techniques to different kinds of practical situations.

In order to make our statisticians more practically oriented so that

they do not consume much time in acquiring the necessary skills for tackling various types of practical problems in the particular field of application, the following suggestions were made :

(a) Project experience may be made essential for all students pursuing a master's degree course. It would be desirable for the post-graduate students in Statistics to have training for a couple of months in industrial units or government departments. The training may be arranged during the first year summer vacation or any other period in which they get a month's holiday or more. Two such one-month periods could be utilized for this purpose.

(b) A post M.A./M.Sc. programme (preferably a diploma) in applied Statistics may be organized in the universities for the benefit of statisticians and others who would like to get an insight into the practical applications of statistical theory to different situations.

(c) New techniques like industrial engineering techniques, techniques of computer science, techniques of mechanical tabulation, inventory control, linear programming, replacement, queuing theory, sequencing game theory and the like should be introduced in those universities which do not offer operations research in their curricula for the M.A./M.Sc. students.

(ii) Government departments

The main issue which was stressed in most of the government departments which the committee visited was the fact that students coming out with a degree or a postgraduate degree in Statistics are not very often acquainted with facts like :

(a) sources of official statistics ;

(b) government publications dealing with statistical information ;

(c) organizations/agencies set-up by the government for collection/compilation of data of various kinds ;

(d) procedural details relating to mechanical tabulation.

The heads of the Statistics divisions of the government departments with whom the members came into contact were strongly of the view that sufficient training could be given by our universities in various types of factual information like ; (a), (b), (c) and (d) referred to above. A further suggestion made was the exchange of personnel between the university departments of statistics and the Statistical personnel employed in government departments.

(iii) Training & research institutions

The committee also visited selected research institutions/universities where training as well as theoretical research was being carried out. The general opinion was that statisticians coming out of our universities were by

and large capable of rising to the situation and acquire the necessary skill for taking up specific research assignments or teaching assignments as the case might be.

Another suggestion made was that teachers, faculty members, and research workers in other disciplines are badly in need of some kind of training in the fundamentals of statistics and to this end it would be necessary to organize part-time courses preferably in the evenings and where possible occasional seminars, summer institutes could be organized. Institution of special research fellowships for attracting suitable candidates to undertake research work was another suggestion made. The considerable variation in the emphasis on practicals was also pointed out and it was desired that live examples could be given in a liberal measure to the students while giving lessons in practicals.

The main points emphasized by the potential employers in the different sectors viz., industry/government/research and training organizations are summarized below :

(a) A graduate course in statistics should make a student fully equipped to be useful in whatever profession he chooses whereas a postgraduate course should concentrate on specialized fields in all aspects, with more emphasis on theoretical aspects.

(b) As far as possible teaching should be more problem oriented at the postgraduate level and 'live examples' should be given in 'practicals'.

(c) A paper on 'operations research' should be made compulsory for all students of statistics at postgraduate level who desire to join industry.

(d) Training in computer technology has become a necessity for the industries. Computer science should form part of the syllabus in numerical analysis.

(e) Postgraduate diploma courses should be started in the universities (evening courses) in applied and theoretical statistics.

(f) Special research fellowships for working in industrial and government establishments might be instituted for attracting suitable candidates for research.

(g) There should be an exchange of teachers from the university departments of statistics and active professional statisticians in government departments/industrial undertakings.

(h) Due to the increasing pace of industrialization, it is necessary that :

(a) applications of statistical methods in industry are dealt at the undergraduate level ; and

(b) short term in-service training to students at postgraduate level is made compulsory.

LIST OF INDUSTRIAL UNDERTAKINGS/GOVERNMENT DEPARTMENTS/RESEARCH & TRAINING INSTITUTIONS VISITED BY THE STATISTICS REVIEW COMMITTEE

(a) *Industrial undertakings*

1. Hindustan Levers, Bombay
2. N. C. Corporation, Bombay
3. Kirloskar Oil Engines, Poona
4. The Gujarat Refineries, Baroda
5. Sayaji Mills, Baroda
6. Jyoti (Pvt.) Ltd., Baroda
7. Sarabhai Chemicals, Baroda
8. Alembic Chemicals, Baroda
9. New India Industries, Baroda
10. Calico Mills, Ahmedabad
11. Indian Aluminium Company, Calcutta

(b) *Government departments*

1. Bureau of Economics & Statistics, Gujarat Government, Ahmedabad.
2. Directorate of Health, Gujarat Government, Ahmedabad.
3. Bureau of Economics/Statistics, Government of Rajasthan, Jaipur.
4. Directorate of Agriculture, Government of Rajasthan, Jaipur.
5. Planning Cell of the Secretariat, Government of Rajasthan, Jaipur.
6. State Statistical Bureau, Government of West Bengal Calcutta.
7. Anthropological Survey of India, Calcutta.
8. State Statistical Bureaux, Government of Assam, Shillong.
9. Bureau of Economics/Statistics, Kerala State, Trivandrum.
10. Bureau of Economics/Statistics, Mysore State, Bangalore.

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11. Bureau of Economics/Statistics, Andhra Pradesh, Hyderabad.

12. Directorate of Scientific Evaluation, Ministry of Defence, New Delhi.

13. Defence Science Laboratory, New Delhi.

14. Army Statistical Organization, New Delhi.

15. Indian Standards Institution, New Delhi.

16. Central Statistical Organization, New Delhi.

(c) *Research and training institutions*

1. Department of Business Management Studies, University of Bombay.

2. Data Processing Centre, University of Bombay.

3. School of Economics, University of Bombay.

4. Gokhale Institute of Politics & Economics, Poona.

5. National Chemical Laboratory, Poona.

6. Armament Research & Establishment Development, Poona.

7. University Department of Statistics, Banaras Hindu University.

8. University Department of Statistics, Poona.

9. University Department of Statistics, Sardar Patel University.

10. University Department of Statistics, M.S. University of Baroda.

11. I.S.I. Quality Control Unit, Baroda.

12. Textile and Allied Industries Research Organization, Baroda.

13. University Department of Statistics, Gujarat University.

14. Ahmedabad Textile Industry's Research Association, Ahmedabed.

15. Physical Research Laboratory, Ahmedabed.

16. Indian Institute of Management, Ahmedabad.

17. University Department of Statistics, Rajasthan University.

18. University Department of Statistics, Calcutta University.

19. Bengal Immunity Research Centre, Calcutta.

20. Indian Institute of Social Welfare & Business Management, Calcutta.

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21. Indian Institute of Management, Calcutta.

22. Indian Statistical Institute, Calcutta.

23. Department of Economics, Calcutta University.

24. Ramakrishna Mission Residential College, Narendrapur, Calcutta.

25. Department of Statistics, Dibrugarh University.

26. Department of Statistics, Gauhati University.

27. Department of Statistics, Madras University.

28. Defence Institute of Physiological Medicine, Madras

29. Indian Institute of Technology, Madras.

30. Indian Institute of Science, Bangalore.

31. I.S.I. Quality Control Unit, Bangalore.

32. Space Science Technology Centre, Trivandrum.

33. Department of Statistics, Kerala University.

34. Department of Statistics, Osmania University.

35. Department of Mathematics/Statistics, Delhi University.

36. Institute of Economic Growth, New Delhi.

37. Delhi School of Economics, Delhi University.

38. Institute of Applied Manpower & Research, New Delhi.

39. Institute of Agricultural Research Statistics, New Delhi.

The members of the Review Committee also held discussions with the heads of departments of statistics of the following universities :-

University		*Place of discussion*
Lucknow	... ...	Department of Statistics Banaras Hindu University
Patna	... ...	Department of Statistics Banaras Hindu University
Vikram	... ..	Department of Statistics M.S. University of Baroda
Bhagalpur	.. ...	Department of Statistics Calcutta University
Utkal	... ...	Department of Statistics Calcutta University

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University		*Place of discussion*
Sri Venkateswara	...	Department of Statistics Madras University
	...	
Mysore	...	Central College, Bangalore
Agra	...	Department of Mathematics/ Statistics, Delhi University
Aligarh	..	"
Meerut	..	"
(Meerut College)	...	
Kanpur	...	
(D.A.V. College)	...	
Punjabi	...	

RECOMMENDATIONS

1. Students who offer statistics in the postgraduate course should have been exposed to statistics at least at the subsidiary level in their undergraduate course. Exceptions may be made in very special cases.

2. It is desirable that universities should arrange practical training for Statistics students during the period of their postgraduate course in some industrial/government concerns.

3. Teaching of statistics should be as far as possible supplemented by illustrative 'live examples' and for this purpose either the universities undertake some projects or close liaison should be established between the universities/government departments/ industries.

4. As practicals from an essential part of the training, it is necessary that the senior teachers of the department be actively associated with the practical classes. Practical exercises should be framed on the 'live data' as far as practicable.

5. Postgraduate teaching in statistics should be imparted preferably by those persons who have sufficient research experience to their credit.

6. As applications of statistics are being increasingly made by the commercial, industrial and business management, it is desirable that statistics should form an integral element both in the B. Com. and M. Com. courses.

7. Courses of statistics should be incorporated in social and biological sciences.

8. Students offering statistics as a special paper in M.A. (Economics) should possess adequate knowledge of Mathematics.

9. It is desirable that research projects be undertaken by the Statistics Departments in collaboration with other disciplines.

10. Statistics students should have acquaintance with the use and working of electronic computer.

11. It is desirable that universities should not open a department

of Statistics unless a qualified professor is available. Also for furtherance of research, the statistics department should have a departmental library, adequate space, sufficient equipments, competent teaching staff and a number of research scholarships.

12. M.A./M.Sc. examination in statistics should be held at least in two parts and about 25% of the total marks should be set apart for internal assessment of sessional work. Wherever in any university there is more than one institution imparting postgraduate teaching in statistics, for maintaining uniform practice, a committee should be formed for the award of marks set apart for internal assessment.

13. Universities may institute post M. Sc. diploma courses on specialized topics in statistics for one year or for longer period.

14. It is desirable that statistics departments should have their own applied sections for project work and also for research workers working in other departments and institutions.

15. Training courses for teachers in new topics like data processing, computer science, information theory etc., be arranged by the universities.

16. Work load of teachers in the postgraduate courses should not be more than 10 hours per week.

17. Some special scholarships, earmarked for statistics students who work in other departments of science should be instituted for closer collaboration between different disciplines.

18. It is desirable that there should be an exchange between teachers in university departments of statistics and active professional statisticians working in industries/government departments.

19. In universities, where the subject is taught in some departments independently of the department of statistics, arrangements should be made to maintain proper standards in teaching and research. For co-operation between different subjects of common interest, a committee be formed of the representatives of the department concerned.

20. Facilities be provided to university departments of Statistics for applied work in statistics.

21. Opportunities should be provided to the teachers of the university departments of Statistics for familarizing themselves with the latest developments in pure and applied statistics.

22. Arrangements for teaching statistics should be made at the predegree stage.

23. There should be some centres of advanced studies in statistics.

24. The syllabi should be continuously reviewed by a committee at intervals of five years.

APPENDIX I

QUESTIONNAIRE FOR ASSESSMENT OF PROGRESS OF STATISTICS TEACHING AND RESEARCH AT UNIVERSITY LEVEL IN INDIA

Department of Statistics Name of University*/College* _____
(Please strike out whichever is inappropriate)

(a) Basic information (i) Year of establishment of the department/year from which facilities for instruction in the subject were started _____

(ii) Is the department of statistics, a separate department/part of mathematics department/in faculty of science/social science _____

(iii) *Courses of instruction provided*

Level	Name of Deg./Dip./Cert awarded
Undergradute	
Postgraduate	
Research	

(b) Physical facilities (*i*) *Library*

Does the department have a separate library _____ yes/no.

If yes the number of books in the departmental library _____

Number of volumes in Statistics in the main University/College Library _____

Does the department get important journals in Statistics : yes/no. If yes the number of such journals _____

(Indian _____ foreign _____)

Is the department adequately equipped with back volumes of important journals _____
_____ yes/no.

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(ii) Laboratory

Has the department adequate facilities for practical work _____ yes/no.

Number of calculating machines in the department _____

Does the department have a mechanical tabulation unit attached to it _____ yes/no.

If yes the names of machines like the punch/ verifier etc., may be given below :

Name   *Number*

(iii) Class rooms

Whether separate classrooms have been provided for imparting instruction at various levels like undergraduate/postgraduate etc. _____ yes/no.

Indicate here the average strength of a class at undergraduate level i. e. B.A./B. Sc./B. Com./Pass course_____

B.A. (Hons.)/B. Sc. (Hons.) course_____
and at postgraduate level i.e.

M.A./M.Sc. course_____

(c) Statistics of Enrolment Staff and 'Turn Over' *Enrolment :* Indicate in the following table the enrolment position as on *1. 9. 67* (Statistics of enrolment is required only in respect of students of the department of statistics at the undergraduate/postgraduate levels).

E n r o l m e n t

Course	*Two year course*			*Three year course*			
	I	*II*	*Tol.*	*I*	*II*	*III*	*Tol.*
B. A.							
B. Sc.							
B. A. (Hons.)							
B. Sc. (Hons.)							
B. A. (Spl.)							
B. Sc. (Spl.)							

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M. A.

M. Sc.

Dip./Cert.

Number of research students enrolled for Ph.D.—

Staff

Total strength of teaching staff in the department_ _____ (1. 9. 67)

Break-up

Professors _____

Readers _____

Assistant Professor _____

Lecturers _____

Assistant Lecturers _____

Tutor/Demons. _____

Turn Over

The number of M.A.s'/M.Sc.s' and Doctorates in Statistics awarded during the last three years may be given below :

Turn Over

Year	*M.A./M.Sc.*	*Ph.D./D.Sc.*
1964-65		
1965-66		
1966-67		

Details of qualifications, teaching experience and out-put of research papers by members of the teaching staff in the Department of Statistics.

S. No.	*Name of staff member*	*Qualifications*	*No. of years of experience*	*No. of research papers published during the last 3 years*
1.				
2.				
3.				
4.				
5.				

Facilities for research in the department and particulars of special research schemes/studies/surveys undertaken by the department during 1965-66, 1966-67 and 1967-68

(a) Indicate below the fields of specialization for which special facilities for research are available.

(b) Names of surveys/research schemes/projects, if any, undertaken by the department during 1965-66, 1966-67 and 1967-68 may be listed below.

Facilities and services offered by the department to other departments in the university regarding data analysis, experimental design etc., short courses in econometrics, biometrics etc.

Details of services offered by the department to other departments in the university regarding data analysis, experimental design and particulars of the short courses in statistics, applied or pure, conducted by the department for the benefit of personnel not directly connected with the statistics department may be given below in the form of a short note.

UNIVERSITY DEPARTMENTS OF STATISTICS

S.No.	University	Year of starting postgraduate degree course in statistics
1	2	3
1.	Agra	1956*
2.	Aligarh	1956
3.	Andhra	1951*
4.	Annamalai	1959
5.	Banaras	1962
6.	Bhagalpur	1958*
7.	Bombay	1948*
8.	Calcutta	1941*
9.	Delhi	1957*
10.	Dibrugarh	1967*
11.	Gauhati	1947*
12.	Gujarat	1955*
13.	Karnatak	1951*
14.	Kerala	1940 M.Sc. by research 1945 M.Sc. by papers
15.	Lucknow	1950
16.	Madras	1931 M.Sc. by research 1949 M.Sc. by papers
17.	M.S. University of Baroda	1953
18.	Mysore	1942*
19.	Osmania	1959

* Departments located in these universities do only postgraduate teaching and research. Undergradute teaching is done in the affiliated/constituent colleges.

1	2	3
20.	Patna	1948
21.	Panjab	1966*
22.	Punjabi	1966*
23.	Poona	1953*
24.	Rajasthan	1961
25.	Sardar Patel	1961*
26.	Sri Venkateswara	1962
27.	Utkal	1958*
28.	Vikram	1961*

*Departments located in these universities do only postgraduate teaching and research. Undergraduate teaching is done in the affiliated/constituent colleges.

COLLEGES PROVIDING INSTRUCTION UP TO POSTGRADUATE LEVEL IN STATISTICS

S.No.	University	List of Colleges
1.	Kanpur	D.A.V. College, Kanpur.
2.	Kerala	Govt. Victoria College, Palghat.
		St. Thomas College, Palai.
3.	Madras	Presidency College, Madras.
4.	Meerut	D.A.V. College, Dehradun.
		D.A.V. College, Muzaffarnagar.
		Janta Vedic College, Baraut.
		Meerut College, Meerut.
		M.M. College, Modinagar.
5.	Nagpur	College of Science, Nagpur.
6.	South Gujarat	Navyug College of Arts and Science, Surat.
		V.S. Patel Arts and Science College, Billimora.

UNIVERSITIES HAVING PROVISION FOR TEACHING STATISTICS UP TO THE FIRST DEGREE LEVEL IN THE AFFILIATED COLLEGES

S. No.	University
1.	Agra
2.	Andhra
3.	Bangalore
4.	Bhagalpur
5.	Bombay
6.	Burdwan
7.	Calcutta
8.	Delhi
9.	Dibrugarh
10.	Gauhati
11.	Gujarat
12.	Indore
13.	Jammu & Kashmir
14.	Jiwaji
15.	Kanpur
16.	Karnatak
17.	Kerala
18.	Madras
19.	Madurai
20.	Magadh
21.	Meerut
22.	Marathwada
23.	Mysore
24.	Nagpur
25.	North Bengal
26.	Osmania
27.	Poona
28.	Rajasthan
29.	Ranchi
30.	Sardar Patel
31.	Shivaji
32.	Saurashtra
33.	South Gujarat
34.	Sri Venkateswara
35.	Utkal
36.	Vikram

UNIVERSITY DEPARTMENTS OF STATISTICS :
ENROLMENT AND STAFF : 1967-68 POSITION

S. No.	University	Enrolment					Staff						Remarks
		Total	U.G.	P.G.	Res.	Dip./Cert.	Total	Pro-fessor	Reader	Lect-urer	Asstt. Lec-turer	Tut./Dem.	
1.	Agra	20	—	19	1	—	6	1	1	3	—	1	
2.	Aligarh	61	7	36	—	18	5	—	1	3	—	1	
3.	Andhra	74	—	43	7	24	10	2	1	7	—	—	
4.	Annamalai	83	59	19	5	—	7	1	—	6	—	—	
5.	Banaras	113	85	21	5	—	8	1	1	6	—	—	
6.	Bhagalpur	64	—	64	—	—	6	—	—	3	—	3	
7.	Bombay	60	—	55	5	—	7	1	1	3	—	2	
8.	Calcutta	44	—	40	4	—	8	1	2	5	—	—	
9.	Delhi	61	—	54	7	—	5	—	2	3	—	—	
10.	Dibrugarh	9	—	9	—	—	2	1	—	1	—	—	
11.	Gauhati	47	—	30	2	15	6	1	—	5	—	—	
12.	Gujarat	32	—	30	2	—	7	—	2	3	—	2	

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No.	Name											
13.	Karnatak	28	—	23	5	—	10	—	1	7	—	2
14.	Kerala	50	—	35	15	—	10	1	2	5	—	2
15.	Lucknow	21	—	20	1	—	6	1	1	4	—	—
16.	Madras	29	—	—	—	29	4	1	1	2	—	—
17.	M.S. University of Baroda	172	138	33	1	—	12	1	2	7	2	—
18.	Mysore	223	180	40	3	—	7	1	1	5	—	—
19.	Osmania	74	50	23	1	—	5	—	1	4	—	—
20.	Panjab	29	—	28	1	—	6	1	1	4	—	—
21.	Punjabi	16	—	13	3	—	5	—	1	2	—	2*
22.	Patna	127	64	62	1	—	13	—	1	9	—	2
23.	Poona	33	—	30	3	—	9	1	2	4	—	3
24.	Rajasthan	50	24	26	—	—	9	1	—	6	2	—
25.	Sardar Patel	18	—	18	—	—	3		1	1	—	1
26.	Sri Venkateswara	98	62	31	5	—	8	—	1	5	—	2
27.	Utkal	39	—	39	—	—	4	1	—	3	—	—
28.	Vikram	17	—	15	2	—	3	—	1	2	—	—

* One instructor and one research assistant.

POSTGRADUATE COLLEGES : ENROLMENT* & STAFF
1967-68 POSITION

S. No.	University of Affiliation	Name of College	Enrolment						Staff					
			Tot.	U.G.	P.G.	Res.	Dip./ Cert.	Total	Prof.	Read.	Astt. Prof.	Lec.	Astt. Lec.	Tu./ Dem.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Kanpur	D.A.V. College, Kanpur.	104	44	60	—	—	5	1	—	—	4	—	—
2.	Kerala	Govt. Victoria College, Palghat.	17	—	17	—	—	4	1	—	—	3	—	—
		St. Thomas College, Palai.	28	—	28	—	—	5	1	—	—	4	—	—
3.	Madras	Presidency College.	98	66	32	—	—	6	1	—	4	—	—	1
4.	Meerut	D.A.V. College, Muzaffarnagar.	52	38	14	—	—	4	1	—	—	3	—	—
		D.A.V. College, Dehradun.	20	—	20	—	—	3	1	—	—	2	—	—
		Janta Vedic College, Baraut.	36	22	14	—	—	5	1	—	—	4	—	—

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		Meerut College, Meerut.	98	75	22	1	—	5	1	—	—	1	3	—
5.	Nagpur	College of Science, Nagpur.	57	45	12	—	—	6	—	—	—	6	—	—
6.	South Gujrat	V.S. Patel College of Arts & Science, Billimora.	30	22	8	—	—	6	1	—	—	3	—	2

*Data has been furnished in respect of those colleges from whom replies were received.
** 1968-69 Data.

U.G. = Undergraduate   Prof. = Professor
P.G. = Postgraduate   Read. = Reader
Res. = Research   A. Prof. = Assistant Professor
     Lec. = Lecturer
     A. Lec. = Assistant Lecturer

TURN OVER OF MASTERS AND DOCTORATES IN STATISTICS
DURING 1964-65, 1965-66 AND 1966-67

S. No.	University	Turn over M.A.'s/M.Sc.'s			Turn over Ph.D's/D.Sc.'s		
		1964-65	1965-66	1966-67	1964-65	1965-66	1966-67
1	2	3	4	5	6	7	8
1.	Agra	13*	8*	9*	—	—	—
2.	Aligarh	8	6	5	1	1	—
3.	Andhra	13	16	15	—	—	—
4.	Annamalai	16	16	11	—	—	—
5.	Banaras	10	8	9	—	—	1
6.	Bhagalpur	18	18	N.A.	—	—	—
7.	Bombay	22	9	15	—	—	—
8.	Calcutta	10	8	16	—	1	1
9.	Delhi	14	10	9	1	1	1
10.	Gauhati	12	10	8	—	—	—
11.	Gujarat	10	11	7	—	—	—

1	2	3	4	5	6	7	8
12.	Karnatak	19	4	10	1	—	1
13.	Kerala	19**	12**	12**	—	—	—
14.	Lucknow	15	11	13	—	—	—
15.	Madras	15	15	15	—	—	—
16.	M.S. University	10	14	10	—	—	1
17.	Mysore	12	13	12	—	—	—
18.	Osmania		5	N.A.	—	—	—
19.	Patna	30	19	10	—	—	—
20.	Poona	10	10	7	1	1	—
21.	Rajasthan	10	13	10	—	2	—
22.	Sri Venkateswara	8	9	9	—	—	—
23.	Utkal	11	18	12	—	—	—
24.	Sardar Patel	6	9	7	—	—	—
25.	Vikram	6	6	7	—	2	1

*These are out-turn of M. Stat's only from Institute of Social Sciences, Agra.
**These include turn over of M.Sc. (Stat.) & M.Sc. (Demography) from the University Department of Statistics, Kerala University.
N.A. : Not Available

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Abbreviations used in Appendix IV (a)

Abbreviation	*Expanded Form*
J.R.S.S.	Journal of the Royal Statistical Society
J.A.S.A.	Journal of the American Statistical Association
C.S.A.B.	Calcutta Statistical Association Bulletin
J.I.S.A.	Journal of the Indian Statistical Association
S.T. & M.	Statistical Theory & Methods (Abstract)
A.U.J.	Annamalai University Journal
A.M.S.	Annals of Mathematical Statistics
I.S.Q.C.B.	Indian Statistical Quality Control Bulletin
A.I.S.M.	Annals of the Institute of Statistical Mathematics
A.J.S.	Australian Journal of Statistics
P.J.M.	Pacific Journal of Mathematics
J.N.I.S.A.	Journal of the Nothern India Science Association
Rev. Int. Stat. Inst.	Review of the International Statistical Institute.

TOPICS OF DOCTORAL THESES IN STATISTICS APPROVED BY THE UNIVERSITIES*
(UP TO 1966-67)

(a) Andhra University

    1.   On some Stochastic Models.

(b) Banaras University

    2.   A study of some inflated distributions.

(c) Bombay University

    3.   Some aspects of the Construction and Analysis of Incomplete Block Designs.

    4.   On some Applications of the Kronecker Product of Matrices to Statistical Designs.

    5.   Some contributions to the Design and Analysis of Experiments.

(d) Calcutta University

    6.   Some Combinatorial problems connected with the design of experiments.

    7.   Contribution to the theory of Non-parametric Tests and Wald's Decision Theory.

    8.   On systematic sampling and problems of statistical analysis.

    9.   On some problems of Multivariate Analysis.

    10.   On characterisation of probability distributions and statistics from specified scholastic relations.

    11.   On some Combinatorial problems in the design of experiments.

    12.   Contributions to the design and analysis of factorial experiments.

    13.   Convergence of Stochastic Process.

    14.   Optimum properties of some Decision Procedures.

    15.   Some problems in probability theory.

*Information furnished relates to only those universities from whom replies were received.

16. A Statistical Study of the population in India.

17. Application of statistical methods in Psychometric analysis and some associated problems in the constructions of statistical tables.

18. Some sequential (two-step and multi-step) inference procedures with Nuisance-parameter from performance in multivariate problems.

19. Order Statistics and their role in some problems of statistical inference.

20. Distribution—free tests of hypothesis—with reference to two sequences of alternatives.

21. Contributions to theory of Dams.

22. Optimum properties of some sequential tests of simple and composite hypothesis and other related inference procedure.

23. Confidence interval for the two means problem with confidence coefficient not less than any pre-assigned probability level and its extension to k means.

24. Contributions to designs and Analysis of experiments.

(e) Delhi University

25. Some aspects of the Statistical Theory of Homogeneous Turbulence.

26. Queuing Theory.

27. Studies in Statistical Theory of Turbulence and Gas dynamics.

28. Efficiency of certain sampling designs.

29. Dependability and disposal decision problems in Operations Research.

30. Queuing Models.

31. Estimation from Censored and Truncated Samples.

32. Studies in Waiting Line Problems.

33. Distributions derived from Real and Complex Multivariate Normal Samples.

34. Random Walks and their Orientation with reference to Special Points.

35. Problems of Construction and Analysis of Designs of Experiments.

36. Distributions involving Special Functions with Bayesian, Objectives in Life Testing.

37. Maintenance Problems in Operational Research.

38. Balking and Reneging in Waiting Line Systems.

39. Some Probability Distributions arising from Parametric Variations.

(f) Gauhati University
40. Problems of Statistical Analysis in Stationary Time Series.

(g) Karnatak University
41. Some aspects of Successive Sampling.

42. Study of Various Queuing Systems.

(h) Kerala University
43. On the exact distribution of Wilk's L_{mvc} and L_{vc} criteria.

44. Studies in Multivariate Analysis.

(i) Patna University
45. Some Studies on Autogressive Schemes of First and Second Order.

46. On Unbiasedness of some designs and Validity of F-test for them.

(j) Poona University
47. Contributions to the theory of statistical estimation.

48. Contributions to estimation of parameters from truncated and censored samples.

49. Contributions to the theory of maximum likelihood estimation of parameters.

50. Contributions to the method of maximum likelihood and to estimation from truncated samples.

51. Contributions to multiplicative processes and a study of some distance functions.

52. Some non-parametric tests of statistical hypothesis.

(k) Rajasthan University
53. Some contributions to multivariate analysis.

(l) Vikram University
54. On power function of a sometimes pool test procedure in a linear hypothesis model.

55. A critical analysis of the game of bridge from statistical viewpoint with special reference to the master pair event.

56. On the statistical inference of a test procedure in a linear hypothesis model on the basis of preliminary tests of significance.

(m) Madras University

    57.   Studies in Sequential Tests.

    58.   Studies in Statistical Inference.

    59.   Specifications of suitable schemes for Time Series analysis.

(n) M. S. University of Baroda

    60.   Standardization of silent reading tests in Gujarat.

    61.   Problems in Multivariate Analysis.

    62.   Fitting of Non-linear Curves of the type $\alpha + \delta^x + \beta \delta^x$

LIBRARY AND LABORATORY FACILITIES IN THE UNIVERSITY
DEPARTMENTS OF STATISTICS

S. No.	University	Is there a sep. depl. library	Tot. No. of books (dep) main library	No. of journals being subscribed	No of calcu-lating machs.	Tabulation Equipment			Other Machines
						Punch	Verifier	Sorter	
1	2	3	4	5	6	7	8	9	10
1.	Agra	No	500	—	50	1	1	1	1
2.	Aligarh	No	NA	6	34	—	—	—	—
3.	Andhra	Yes	750	—	30	—	—	—	—
4.	Annamalai	Yes	2639	12	39	—	—	—	—
5.	Banaras	No	400	8	25	2	2	1	1
6.	Bhagalpur	Yes	NA	NA	18	—	—	—	—
7.	Bombay	No	NA	NA	54	7	7	1	1
8.	Calcutta	Yes	3500	112	77	2	2	1	—
9.	Delhi	No	NA	NA	26	—	—	—	—

10.	Gauhati	Yes	623	25	24	—	—	—	—
11.	Gujarat	—	6437	18	40	—	—	—	—
12.	Karnatak	No	1500	25	48	2	2	1	1
13.	Kerala	Yes	4972	51	50	5	5	2	5
14.	Madras	Yes	1112	15	15	—	—	—	—
15.	M.S. University	No	NA	NA	43	There is a mechanical tab. unit.			
16.	Mysore	NA	1800	26	31	—	—	—	—
17.	Osmania	Yes	600	19	57	—	—	—	—
18.	Punjab	Yes	250	27	15	4	2	1	3
19.	Patna	Yes	3401	18	79	6	1	1	—
20.	Poona	No	1630	37	94	10	6	1	2
21.	Rajasthan	No	NA	17	32	—	—	—	—
22.	Sardar Patel	No	NA	13	26	—	—	—	—
23.	Sri Venkateswara	No	300	15	24	—	—	—	—
24.	Utkal	Yes	600	10	NA	—	—	—	—
25.	Vikram	No	500	9	24	—	—	—	—

*N.A.   data not available.

SURVEYS/RESEARCH SCHEMES/PROJECTS UNDERTAKEN BY THE DEPARTMENTS OF STATISTICS DURING 1965-66, 1966-67 AND 1967-68

Agra

1. (1965-66)—Study of queues at the outpatient department of the hospital and ration shops.

2. (1966-67)—Patterns of food consumption of various groups of persons in Agra.

3. (1967-68)—Opinions of teachers and students on the medium of instruction for higher studies.

Annamalai

1. (1966-67)—Three research schemes (details not given).

Banaras

1. Demographic survey of third grade employees of Banaras Hindu University, 1966.

2. Establishment of a demographic research centre.

3. Establishment of a computing unit.

4. Seminar on statistical methods sponsored by University Grants Commission in 1966.

Bhagalpur

1. (1965-66)—Survey of Rickshaw pullers of Bhagalpur.

2. (1966-67)—Survey of Police Constables of the District of Bhagalpur.

3. (1967-68)—Socio economic survey of the school teachers of Bhagalpur District.

Bombay

1. Experiments on sensitivity of light on skin (1965).

2. Diabetic Survey (1965-66).

3. Experiments on the efficiency of different medicines on Cholera patients (1966-67).

4. Election Survey (1967).

5. Numerical calculations for multivariate model (1967).

Calcutta

1. A Techno Economic Survey of Engineering Industries in Hawrah.

2. An analysis of trends in India's Foreign Trade.

3. Working conditions of colleges affiliated to the University of Calcutta—an Educational Survey.

4. Examination Reforms.

Delhi   1. Random Walks and their orientation with reference to special points.

2. Path methods in random walks.

Karnatak   1. (1965-66)—Socio-economic studies : Pilot Surveys of eight villages in Dharwar Taluk were conducted with the financial assistance from the University.

2. (1966-67)—Demographic Survey of Mansur village, situated in the neighbourhood of a developing industry.

Kerala   1. (1965-66)—Survey methodology for the measurement of fertility; study of certain characteristics of the population in radiation belt from Neendakala to Aalapad.

2. (1966-67) and (1967-68)—Family Planning communication and action Research Programme
(a) Standard fertility survey
(b) Continous population register
(c) Action Research Programme.

Madras   1. (1965-66)—Survey on Height & Weight of College students.

Patna   1. (1965-66)—Survey on attitude of non-teachers towards present day education.

2. (1966-67)—Socio-economic survey of Secondary & Higher Secondary teachers.

3. (1967-68)—Survey on the attitude towards family planning —data collected jointly by students of the department and members of staff of the Demographic Research Centre.

Rajasthan   1. All India School in 'Survey Research Techniques' was organized during October-November, 1966.